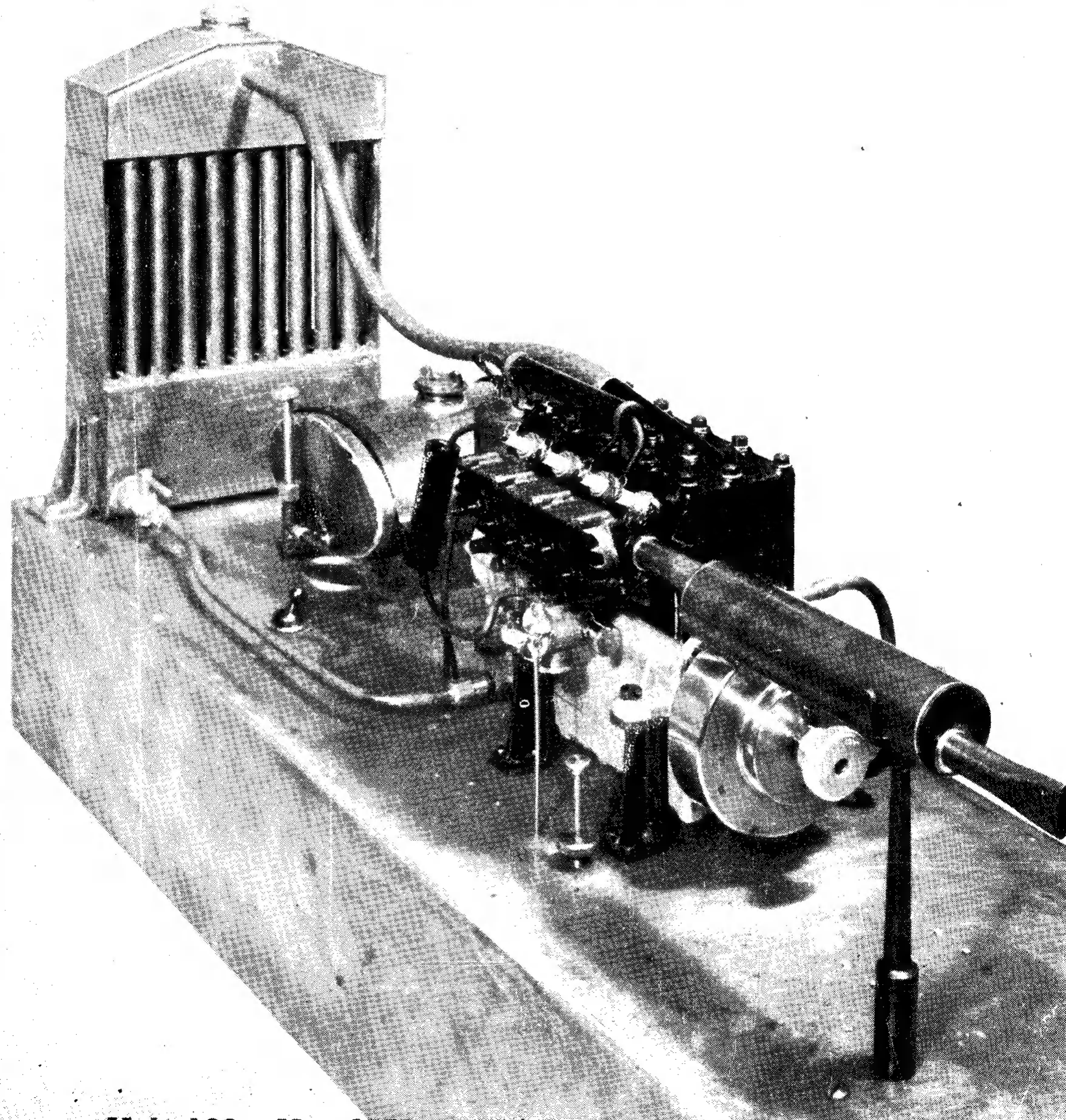
THE MODEL ENGINEER



Vol. 102 No. 2552 THURSDAY APRIL 20 1950 9d.

The MODEL ENGINEER

PERCIVAL MARSHALL & CO. LTD., 23, GREAT QUEEN ST., LONDON, W.C.2

20TH APRIL, 1950 VOL. 102 NO. 2552

SMOKE RINGS

Our Cover Picture

● THIS WEEK'S photograph depicts what we believe to be the ideal type of power unit for the future scale model car enthusiast, only in 15-c.c. form. It is the four-cylinder side-valve "Seal Minor" engine, by A. Bontor, a type which attracted great attention and much admiration at the 1949 "M.E." Exhibition.

At least three of these units, scaled down to 10 c.c., are being built at present and, as mentioned by "Clubhound" in a recent issue of THE MODEL ENGINEER, a four-cylinder, twin overhead camshaft 10-c.c. racing engine of free-lance design is well on the way.

We predict that it will not be long before a team of "four"-powered cars will be showing their paces and from there, well, it will be a mere stone's throw to a radio-controlled Grand Prix!

A Prize for a Locomotive

● MESSRS. A. J. REEVES & CO., of Birmingham, suppliers of castings and materials for a large number of "L.B.S.C.'s" locomotives, have very generously donated a voucher, to the value of £5 5s. 0d., as a prize to be awarded to the best locomotive between $2\frac{1}{2}$-in. and 5-in. gauge in the "M.E." Exhibition Competition Section. This prize will be awarded, of course, at the discretion of the judges.

Banbury Goes Ahead

● WE LEARN from Mr. A. Trainor, the hon. secretary, that the new society recently formed in Banbury will be known as the Banbury Model Engineering Society. Activities seem to have got going to a good start; the fitting out of a workshop is progressing well, and already some few aircraft have been made, to gain prizes at the local Arts and Crafts Festival.

The model railway section has a stretch of baseboard laid and a layout planned. The locomotive people have decided to build an 0-4-0 saddle-tank "Ann of Holland" as a club model, and the general section has started on the construction of a ship and some other models. All this shows quite clearly that Banbury has no intention of lagging behind in club activities; may all success attend their efforts!

A Husband Who Made Good

● WE HAVE received a very human story from Mr. J. W. Spafford, of Nottingham. He was interested in the article "Model Widows," published in our issue for March 9th, because he thought he could see in it some reflection of his own experiences. He was one of those husbands who was always in the workshop "pottering about and making awful noises." He tried leaving the tools alone for a bit, at his wife's request, because, as she put it, he seemed to think more about them than he did of her.

But he was full of the urge to get into the workshop again because he had begun to build a $2\frac{1}{2}$-in. lathe. Somehow, he pressed on whenever the opportunity occurred, and the lathe began to take shape. Still, there was no interest on his wife's part, and he thought that something *would* have to be done about it.

In due course, the lathe was entered in the competition section of the Nottingham Society's annual exhibition. Mr. Spafford had never entered anything before, and on the evening of the second day of this particular show, he asked his wife in a casual sort of way if she would care for a walk, to look around the exhibition. To his astonishment, she said she would!

A little later, they saw some exhibits displaying award tickets, and Mrs. Spafford remarked: "I wonder if there is anything on your lathe?" And, proceeding to the end of the table where the lathe was situated, they saw that it "wore" a ticket bearing the words "First Prize"!

Since then, there have been no complaints about "awful noises"; they seem, somehow, not to sound quite so bad as they used to. Moreover, Mrs. Spafford has shown a lot more interest in what her husband does. By way of recompense, he tries to do as much as possible to ease those household problems that "Workshop Widow" wrote about; he bought an old sewing-machine, made a few new parts for it, motorised it, made a new base for it and re-enamelled it. It now plays a prominent part in easing the household sewing and mending.

A dinner-gong, twisted candlesticks and photograph-frames to match, with metal parts chromium-plated, have also been made, and all is bright in the Spafford home. The good lady is no longer a "Model Widow" but a "Model Companion," and we are very glad to know that.

A Canadian Reader's Appreciation

● MR. FREDERICK MASSEY pays us a generous tribute in a letter in which he writes:—

"In 1945 I wrote to you, telling you how much I appreciated the value of THE MODEL ENGINEER in giving me the incentive to go after a technical education through night classes, etc., and how THE MODEL ENGINEER taught me the tricks which enabled me to take on bits and pieces for the war effort. All this finally resulted in being offered a job looking after the sewing machines in a large garment factory (after 20 years in a bank).

"This job lasted for $4\frac{1}{2}$ years and has now led to the most interesting job I have ever had—Service Engineer for the three maritime provinces of New Brunswick, Nova Scotia and Prince Edward Island, for an oil company.

"The connection is this: 'L.B.S.C.' has often mentioned 'Cyltal' steam cylinder oil and 'Cutmax' cutting oil. I found out that these were Houghton products and became interested in the E. F. Houghton Co., asking their representative, who made an annual trip around these provinces from Montreal, to call on me. This was when I was looking after the sewing machines. I bought some 'Cutmax' and also some soluble quenching oil and soon found that the E. F. Houghton Co. was sending me its trade magazine *The Houghton Line.*

"Then the garment firm folded up, and I decided to go to Toronto to see if they would take me on as the maritime representative. And they did.

"I have now been on this job for nine months and it is what I have wanted all my life. I visit almost every place that has a smokestack and the experience is of never-ending interest.

"So, thanks, 'M.E.' and thanks 'L.B.S.C.' What prompted me to write is that my son (age 9) is getting interested in THE MODEL ENGINEER, and I fell to wondering if it will be an influence in his life, too."

A New Film—"The Locomotive"

● THAT LOCOMOTIVE engineers might be excellent film-producers is, perhaps, a rather startling idea, at first sight. However, we were recently privileged to attend a private viewing of a new film just completed by the Locomotive Manufacturers' Association of Great Britain, and any doubts that we may have had on the juxtaposition of professional locomotive engineering and film production have been laid low!

The film, which is of thirty minutes duration, is a 16-mm. sound-colour film dealing with the birth of the locomotive in England, its introduction to the world, its evolution and development to suit the varied conditions of gauge, grade, curvature and climate of railways throughout the world, and illustrative of the capacity of the industry in design and manufacture. It refers to the pioneers, culminating with the "father of the locomotive," George Stephenson, mentions the delivery of the first locomotives to the Continent and America, and traces the gradual development from single to 4-wheeled, 6-wheeled and 8-wheeled locomotives to the powerful articulated type of double 8-coupled and diesels.

Naturally, in half and hour, nothing like an adequate picture of the industry as a whole can be given; but there are glimpses of steel and iron foundries, forging and machine tools, boiler and erecting shops.

The film concludes by giving overseas action-pictures of locomotives manufactured by the industry. It is hoped that it will be interesting, not only to railways overseas, but also to students in schools and technical colleges and to technicians and others associated with the locomotive in production and operation.

There is a running commentary in English, but for use overseas this will be in the appropriate language.

The film is available free on loan to bona fide establishments, and applications for it should be made to the Locomotive Manufacturers' Association, 82, Victoria Street, London, S.W.1.

*A Small Instrument Lathe

for Home Construction

by E. G. Lewis, M.A.

THE barrel, which is bored No. 0 Morse at the front end, has a nut fitted into the rear end which is tapped ¼-in. Whit. l.h., and the corresponding screwed shaft is carried in a knurled thimble as shown in section in Fig. 4 (*a*). The screwed shaft is equipped with a flange and a ballthrust washer, and the thimble is attached to the tailstock by a bayonet fitting, allowing for quick release. On the back of the thimble a loose collar is free to rotate, and in this radially drilled holes form sockets into which fits a spring-loaded fork attached to the hand lever. This lever pivots on a screw in a bracket carried on the rear of the tailstock, and so is readily detachable.

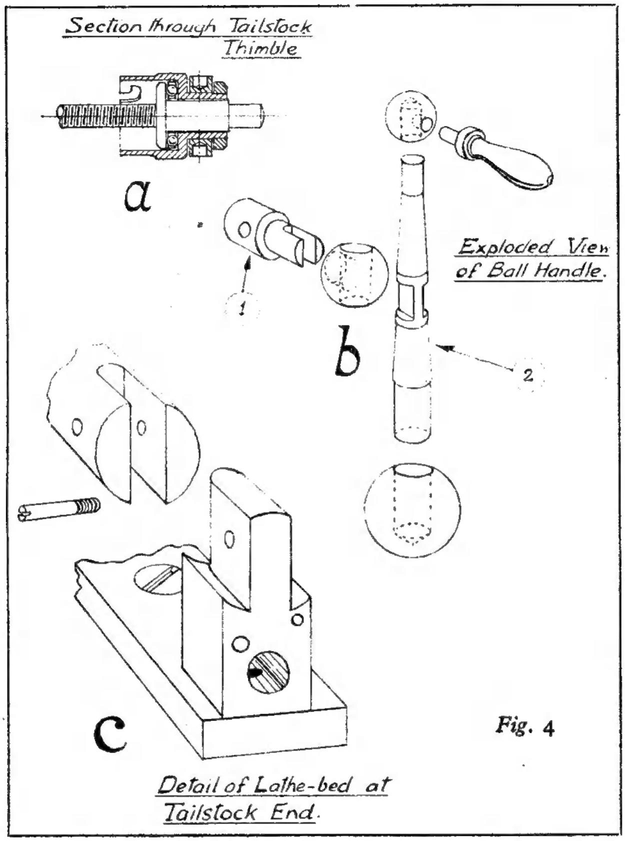


Fig. 4

To use the lever-feed attachment, therefore, it is only necessary to screw out the barrel with the ball-handle as far as it will go, clip on the lever with the fork engaging the sockets in the collar, and release the thimble bayonet fitting.

Ball-handles the Easy Way

For the tailstock, as well as for the cross-slide, ball-handles are necessary and the writer funked making these in the usual way which requires some device for spherical turning. As an experiment, therefore, it was decided to try a built-up one using commercially available steel balls, and after some thought the method of assembly shown in Fig. 4 (*b*) was hit upon, and found to be entirely satisfactory; in fact, I doubt very much whether an elegant ball-handle can be made as quickly from the solid even when the necessary tools are to hand. The steel balls were softened by being heated for some time to redness over a gas-ring and allowed to cool slowly. They were then drilled as shown (dimensions are not given as these must vary to suit individual requirements). The cross-drilling at right-angles of the medium and smallest-sized balls was done in a lathe in the s.c. chuck, after a short length of silver-steel of appropriate size had been inserted in the first hole drilled. By setting this rod parallel with the face of the chuck before finally tightening up, right-angled holes were ensured. The short thimble (1), which was to be pinned to the shaft, had its outer end turned down to (in the present case) a ¼ in. diameter spigot to fit the holes in the medium-sized ball. The tapered stem (2) of the handle was next put in hand and a portion in the centre was turned parallel, ¼-in. diameter, to pass through the same ball. Clearances were then filed as shown (great accuracy is not necessary) to enable both tapered stem and spigot to enter (in that order) their respective holes.

The sketch in Fig. 4 (*b*) is otherwise self-explanatory, and after assembly with appropriate surfaces painted with borax, the whole was cooked up to cherry-red and silver-soldered. Five minutes vigorous application of emery cloth produced a brightly polished and professional-looking ball-handle.

*Continued from page 523, "M.E.," April 13, 1950.

Back Support for Bed

So far it has been explained how the bed was constructed of two bars, one round and one flat, secured in accurate alignment at the headstock end. It was realised, however, that considerable additional rigidity would be secured by tying these bars together at the tailstock end by a small (and necessarily removable) strut. The precise form of this is shown in the sketch, Fig. 4 (*c*). The strut, which was cut from ½-in. sq. m.s. to be a good fit in the diametral slot on the end of the ¾-in. ground bar, is attached to the rectangular bar by a tight-fitting set-screw and to the round bar by a parallel pin with threaded end. A clearance hole is provided for the leadscrew which is carried in bearings in a bracket, attached by set-screws to the strut. Thus, if it is required to remove the tailstock for any purpose, the set-screws and parallel pin holding the rear strut are removed whereupon the whole leadscrew unit can be withdrawn.

A Leadscrew That Will Not Mislead

The leadscrew presented a problem the solution of which, in my case, may provide a guide to other home constructors similarly placed. If this was to be a "precision" tool it was necessary that the leadscrew should be of equivalent accuracy and, what is even more important, that endplay, so often present in small commercial lathes, should be eliminated without introducing periodic errors. What was wanted was a precision Acme-threaded screw and nut of preferably 8 t.p.i. (l.h.) at a reasonable price. All I could find of the necessary precision, however, at the time was a 10 t.p.i. Acme-threaded screw and nut (r.h.) from a Government surplus predictor gear, at a cost of 2s. 6d. The threaded portion of the screw was of adequate length but the plain shank was short; this was easily lengthened. The bronze nut was ideal having set-screws and dowel pins by which it could be attached to the saddle, and for a portion of its length the nut was split longitudinally and capable of being closed slightly by small bolts to take up backlash. Nevertheless, I was determined that the rotation of the leadscrew handle should be normal. Eventually a method of construction was adopted which (a) allows the handle to operate as for a l.h. leadscrew, (b) enables the effective pitch to be 8 t.p.i. as desired, and (c) eliminates all endplay and periodic error from thrust surfaces, most effectively. The design will be apparent from the photographs and from Fig. 3, but briefly it consisted in mounting a separate front-shaft with handle, geared to the leadscrew by a 50-tooth and 40-tooth wheel respectively. This left the end of the leadscrew (suitably centre-drilled) accessible for applying end-thrust via a hardened steel ball and plane-ended adjusting screw (with locknut). Thrust in the other direction was taken by the truly perpendicular face of the gear-wheel boss, pinned to the leadscrew, against the brass bearing-plate, which did not therefore need to be so accurately perpendicular to the axis. The handle

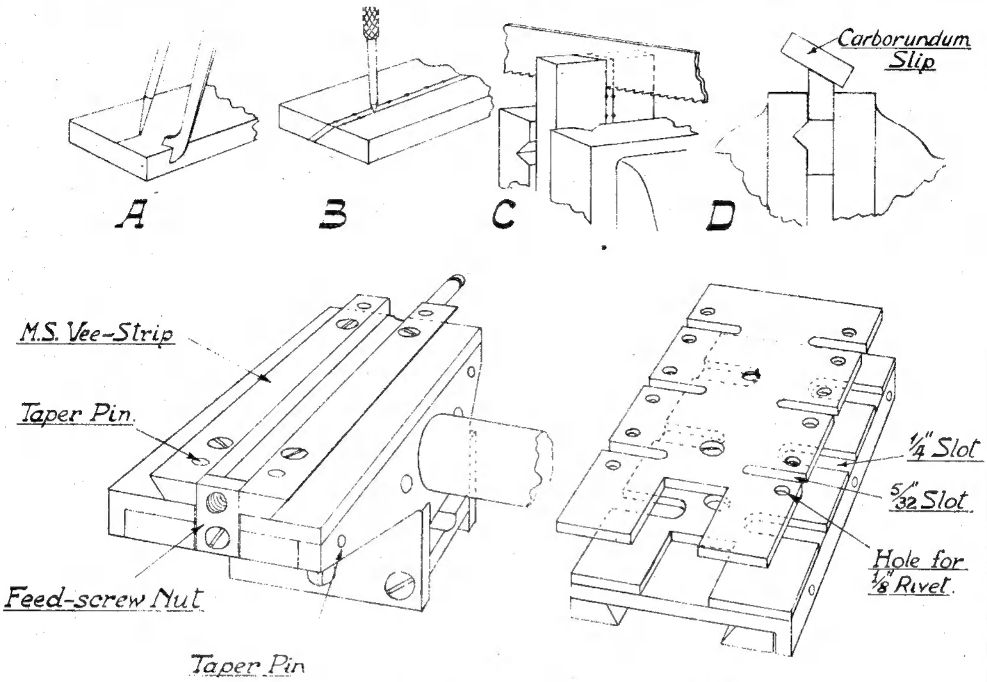


Fig. 5. Construction of saddle and cross-slide

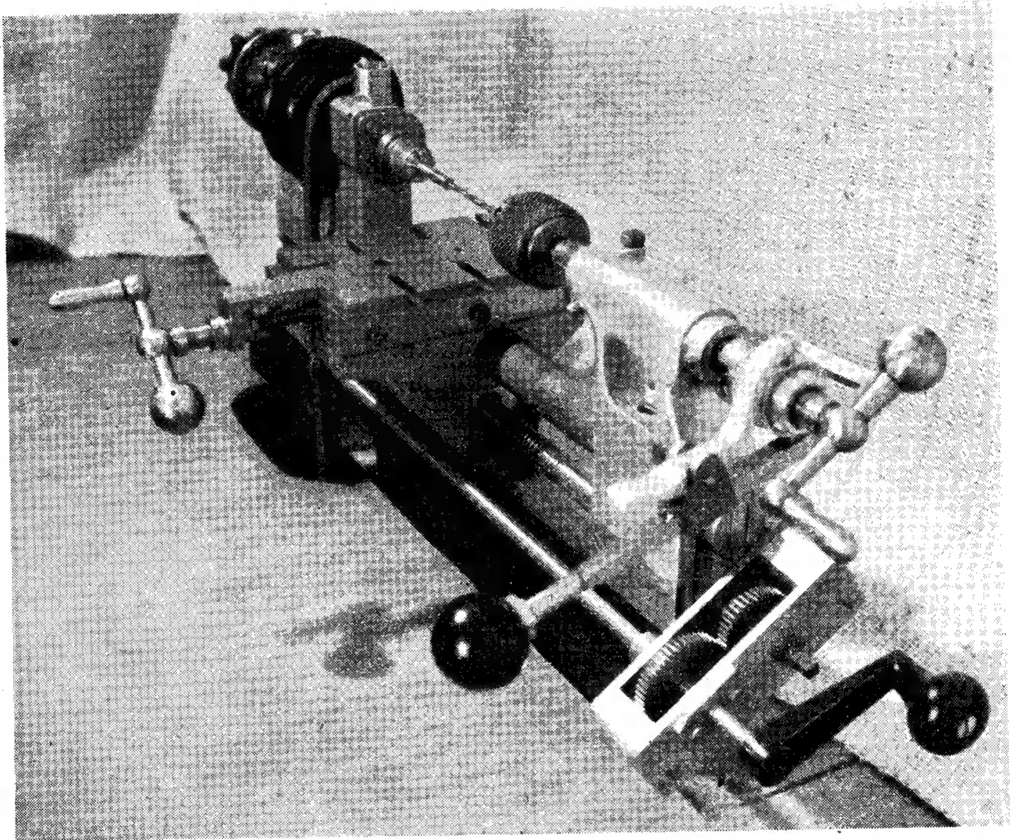
on the front shaft, though it appears massive in the photograph, is actually exceedingly light being a magnesium alloy die-casting from some surplus aircraft radio equipment, and was therefore not balanced.

The Saddle

This item, depicted in Fig. 5, I will not describe in detail except to say that it comprises headstock and tailstock, and it was to one of these that the bronze nut for the leadscrew was fixed.

Making Vee-slides

For the cross-slide and top-slide I decided on orthodox vee's, and these were duly built up from C.R.S. bar. This method of construction has been described several times in the pages of



Using the lever-feed for fine drilling of steel rod held in watchmaker's collet

a sandwich of available chunks of scrap duralumin between cheek-plates of hard brass, the whole being carefully bedded together and held by large taper pins and $\frac{1}{4}$-in. Whit. long set-screws, before the tunnel for the $\frac{3}{4}$-in. ground bar was drilled and reamed. The block was mounted on the angleplate, on the faceplate for this purpose so as to ensure parallelism with the top face of the saddle on which the cross-slide was to be mounted. The $\frac{3}{4}$-in. bore was provided with a radial slot for adjustment and was filled with a packing-piece, whose thickness was progressively reduced, while the internal surface was scraped until it bedded down all over as shown by the use of blue marking. Steel cheeks were provided to prevent rotation of the saddle in much the same way as already described for THE MODEL ENGINEER so I will not go into it in great detail. At the time I was starting mine, however, I had not seen any article on the subject and was therefore somewhat apprehensive about what appeared to be a rather tricky operation. I can assure any reader who is competent to handle a hacksaw and file with firmness and delicacy, and who is not above trying a few experiments with a scraper and a piece of plate-glass and mechanics' blue, that the production of beautifully fitting slides by this method is almost child's play. As my method of making the vee strips is somewhat different from what has been previously advised, and shows some economy in removal of metal, the principal steps in the process are outlined in thumbnail-sketch form at the top of Fig. 5.

A shows the piece of 1 in. × $\frac{1}{4}$ in. C.R.S. bar being marked out with a pair of shouldered odd-leg calipers with scribed lines at $\frac{9}{16}$ in. and $\frac{3}{8}$ in. from opposite edges. The piece is turned over about the longitudinal axis of the strip and marked out again in the same way. The lines are then centre-popped as at *B*. The bar is up-ended in the vice and sawn obliquely through along the length as at *C*. This is the step which needs most care if unnecessary work is to be avoided. If this has been neatly done, a relatively small amount of metal will need to be removed with a smooth file followed by a carborundum slip as at *D*. The oblique surfaces are now tested for flatness with a piece of plate-glass and mechanic's blue, and one at least must be scraped flat as a standard. The two vee-slips, which are intended to mate, are laid flat in appropriate position on a truly flat surface, which may be of plate glass or the top of the saddle after it has been filed and scraped to flatness. One vee-strip (the standard) should be clamped down with toolmaker's clamps while the other is rubbed along it, keeping it in contact with the flat surface. Any incorrectness of angle or high spots on the second piece are corrected by filing and scraping until perfect contact is obtained.

One of the strips is now fixed to the saddle, at first by one end only, with a tight fitting taper pin. It is adjusted about this pin until exactly perpendicular to the centre-line of the lathe, clamped with a toolmaker's clamp and the second taper-pin hole drilled, reamed, and the pin knocked home. Another vee-strip of a second mating pair is fitted in like fashion on the saddle and, before fitting its second taper pin, adjusted for parallelism by sliding the two loose strips along in contact with their fixed mating strips. At the same time the outside measurement over all the strips (at the mid-point of the loose pieces) is taken at intervals with a micrometer or, if one has a delicate touch, with calipers. If this measurement remains constant the fixed vee-strips are parallel and may be finally secured with taper pins and set-screws. The attachment of the corresponding pieces to the cross-slide is straightforward, and one is adjustable by Allen grub-screws and locknuts until the desired degree of stiffness is attained.

A Tee-slotted Boring Table

Although height of centres was strictly limited and an orthodox swivelling top-slide was required, the writer did not wish to forgo the advantages of a cross-slide in the form of a tee-slotted boring table. To keep height to an absolute minimum, therefore, recourse was had to a method of building up this tee-slotted table from $\frac{1}{8}$-in. × $2\frac{1}{2}$-in. ground bar. This was of very tough steel and is not readily deformed by tightening down the tee-bolts, however tightly. The construction should be clear from the exploded view in Fig. 5.

In addition to the tee-slots the table has a $\frac{1}{4}$ in. diameter hole to receive a spigot on the bottom of the top-slide, thereby enabling the latter to be equipped with a proper protractor scale graduated to 30 deg. on either side of zero.

In order that the cross-slide can conveniently be used for boring and light milling, the travel has been made as long as possible, the support for the feed-screw being overhung at the front. Something of a novelty was provided to indicate the cross-feed of this table. The ball-handle has a plain portion provided to take the usual graduated collar; but since this would take no account of backlash or of wear in the screw, which was probably inaccurate to start with (being a length of $\frac{1}{4}$-in. Whit. studding turned down at one end), a dial-gauge graduated in 1/100 mm. divisions was mounted on the back of the saddle. The ball-ended plunger bears directly against the rear end of the cross-slide and thus indicates its position over any range of 11 mm. The dial-gauge is mounted very simply; a short length of $\frac{1}{4}$-in. silver-steel rod was screwed $\frac{1}{4}$-in. Whit. at one end and fitted into a similarly tapped hole in the back of the saddle, and a block made from $\frac{1}{2}$-in. sq. m.s. clamps both on to this rod and on to the stem of the dial-gauge. This enables the gauge to be adjusted and to be removed for safety; the horizontal rod is also useful to carry an adjustable stop for cross-feed, or a magnifier or a drip-can, etc.

A Top-slide Without Tears

The provision of a useful top-slide on a very small lathe is always something of a problem, both because of the serious limitation on height if a reasonable size of turning tool is to be accommodated, and because in nearly every position the handle fouls the tailstock, or one's knuckles foul everything. However, by building it up layer-by-layer, bread-and-butter fashion as for cross-slide, I was able to find room for the following features: a large circular base with circumferential slot for set-screw on one side, and an aluminium protractor scale on the other; a flat-topped slide with $\frac{1}{4}$-in. stud for English type tool clamp, and a clear 9/32 in. between top of slide and height of centres; a dovetail slot in the top face (normally filled by a loose piece to keep out swarf) to enable a special boring tool holder to be substituted.

To minimise the usual interference between top-slide handle and tailstock, a three-way operated feed-screw was devised. A short cross-shaft drives the feed-screw itself by skew-gears, and a knurled handwheel can be slipped on to the feed-screw or one or other square end of this cross-shaft to suit the operator's convenience. The skew gears are right-handed, and the cross-shaft is mounted above the r.h. feed-screw; this combination results in a natural movement of the handwheel in any of its three positions, for the desired movement of the top-slide. The protractor scale, which has previously been mentioned, also carries a linear scale graduated from 0 to 50 mm. by which the travel of the slide can be measured.

Additional Attachments

The whole machine as originally envisaged is not yet complete; there still remains the screw-cutting gear, the dividing gear previously mentioned, and a gear-cutting attachment. A small counter has also been obtained and will be mounted on the headstock for counting turns in coil winding. However, the writer has already

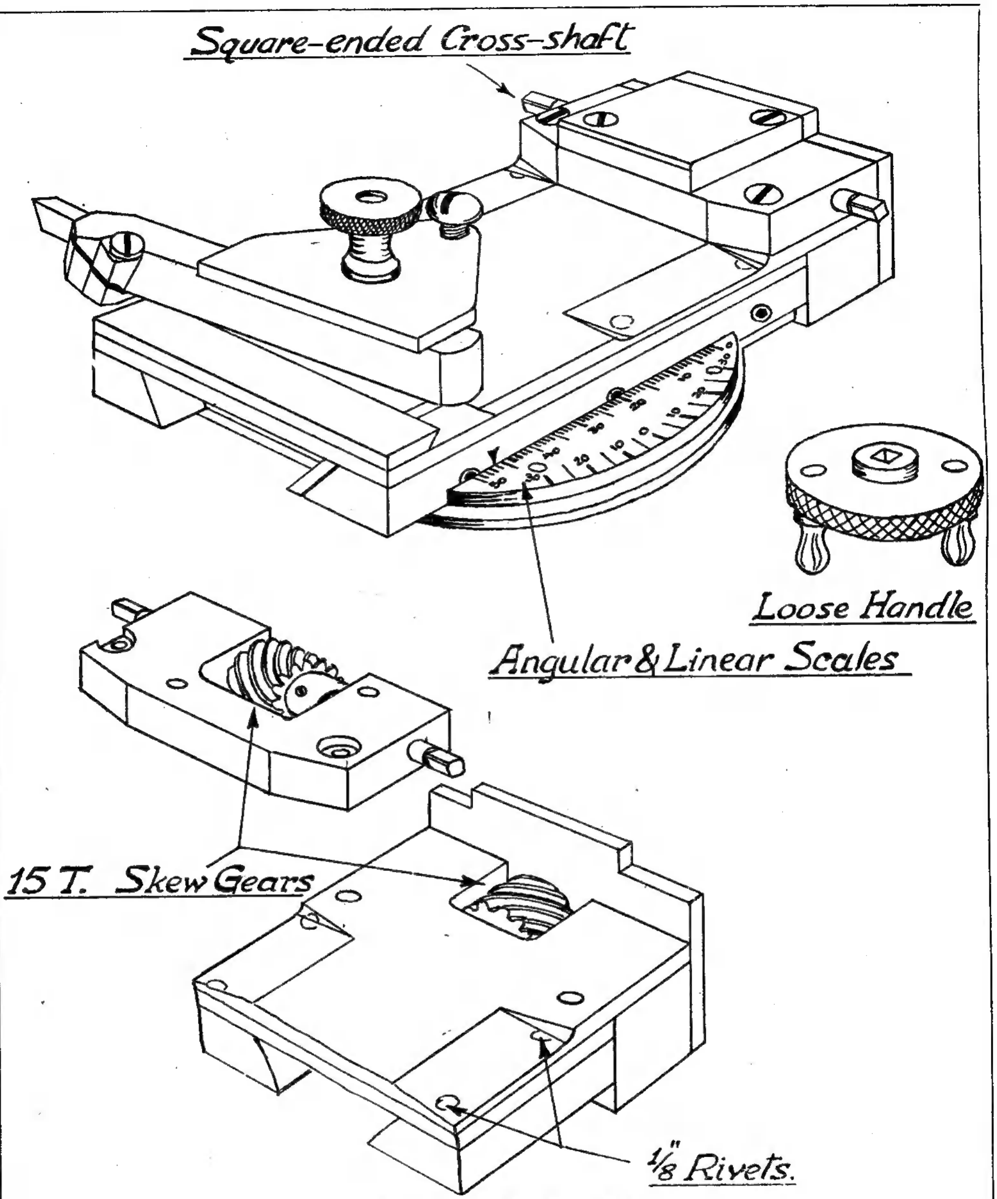


Fig. 6. Details of top-slide

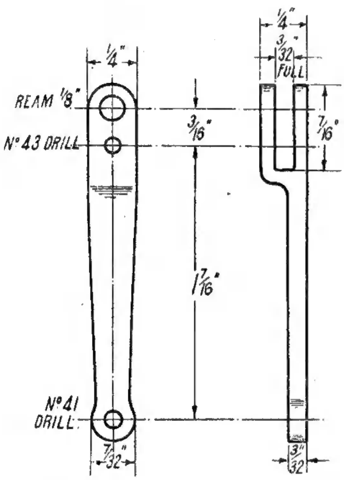
been agreeably surprised by the accuracy and convenience of this little lathe as so far assembled. Parallel turning in the chuck or between centres leaves nothing to be desired; facing is accurate to approximately 1/1,000 in. on a 3 in. diameter disc (the most serious fault discovered); and the response to the feed with a well-ground tool is such that, when turning a silver-steel arbor, a reduction of diameter of 1/1,000 in. produces a perfectly formed continuous shaving which must be examined with a powerful magnifier to be appreciated.

I think the conclusion to be drawn from this is that a very useful machine tool can be produced at home by predominantly hand methods, and a minimum of machining, if one is prepared in advance for the limitations of such methods, and will take advantage of commercially available precision material, ground bar, etc., and design accordingly.

"L.B.S.C.'s" Beginners' Corner

Walschaerts Gear Components for "Tich"

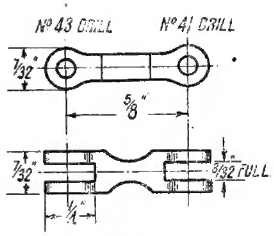
THIS week it is beginners' turn again, so here are some illustrations and notes about the Walschaerts gear parts for the little contractors' engine. In full size, these engines have to put up with a lot of rough handling, and get very little in the way of maintenance, so the gear needs to be simple and robust. Despite that, it is in no way clumsy; in fact, if made to the given measurements, it will be far neater than many at present operating on club and other tracks. In making up the levers, rods, and links, beginners will have a good opportunity to put into practice the lessons they have already learned, which should save your humble servant much needless repetition, and hasten the job of getting the engine on the road. For example, all the forked ends of the rods and levers, such as the combination-lever, union-link, eccentric-rod, and lifting-arms, are slotted out by the same method described for slotting the pump ram, viz. clamping the component under the slide-rest toolholder, packed up to centre height, and running it up to a saw-type milling-cutter mounted either on a stub mandrel held in three-jaw, or on a heavier mandrel between centres. The reduced parts of the combination-lever, radius-rod and eccentric-rod, can be milled from the solid bar, by one of the methods described for milling axleboxes, if a cutter is available. This is run on a stout mandrel between centres, the steel being held in a machine-vice, either regular, or improvised out of angle-iron, and packed up to the correct height. If low speed is used, with plenty of cutting oil, the steel can be milled away like cheese, the sharp radii close to the jaws of the forks being finished with a file. The rounded ends can be finished off in the same manner that I described for coupling-rods. Where no facilities for doing milling in the lathe is available, or the builder of the engine hasn't any cutters, there is always the humble but very necessary file to fall back on; and this, with the average amount of intelligence behind the handle, can always be relied on to do a satisfactory job.



Combination-lever

Combination-levers

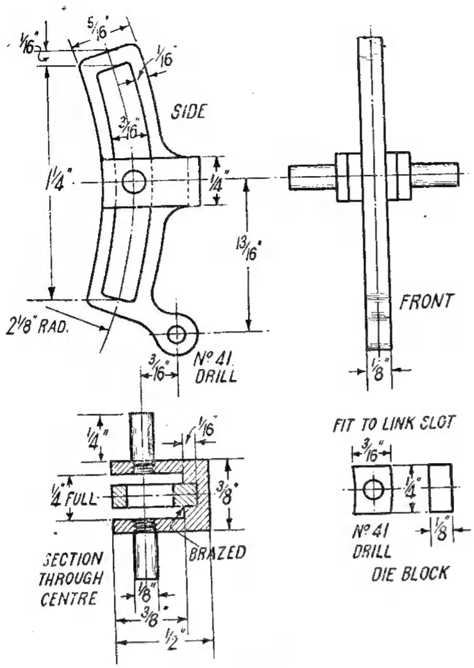
Starting from the cylinders, the first job is the combination-lever, as we already have the wide-jawed valve forks or crossheads. This is cut from a piece of $\frac{1}{4}$-in. square mild-steel approximately 2 in. long. Mark it off, and drill the holes first, using drilling-machine or lathe, as they must go through square with the sides. Next, slot the upper end, as mentioned above; after that, mill or file away the part below the fork, to the sizes given, then round off the ends. Some folk like to see a high polish on steel valve-gear parts; if you are one of these, take a tip from Mr. Tom Glazebrook, and rub them on a sheet of fine emery-cloth which has previously been rubbed with beeswax. Personally, I prefer the working or "tool" finish, same as on full-size engines in "company" days. They get "finished" in another sense now, sad to say! The same kind of combination-lever does for both sides of the engine.



Union-link

Union-links

Each union-link needs a piece of 7/32-in. or $\frac{1}{4}$-in. square mild-steel a little over $\frac{7}{8}$ in. long, to allow for finishing to size. This is an exceedingly simple job. Mark out, drill, and slot the ends as above; round off the ends, then file away the middle, as shown in the plan view, for the sake of appearance. An alternative way, which is a little easier, is to use two separate links made from $\frac{1}{16}$ in. by $\frac{1}{4}$ in. mild-steel, cut out and drilled to the same shape and dimensions, as



Expansion-link

slot-drill, in the spindle, will do the trick easily, the slide-rest being run up to the faceplate, the cutter fed into action by the top slide, and the faceplate moved slowly by hand. Put the back gear in, put the belt on the slowest speed, and pull it by hand very slowly. The resulting slots will naturally have rounded ends, but a small square file will soon bring them to the proper shape, if used with care and discretion.

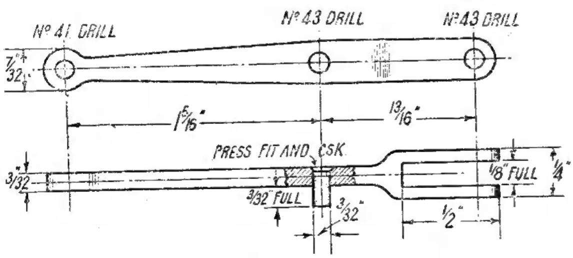
Beginners who do not possess a milling-spindle, can cut the slots by hand quite easily ; in fact, although I have a machine which will cut curved slots, more often than not, I do the job by hand, just to see if I haven't lost my " sense of crafts-manship," in a manner of speaking. I guess most folk have heard of the man who described himself as a motor fitter and mechanic, on the strength of ten years at tightening up one nut on car engines as they passed him on a conveyor belt. Locomotive builders get a little more experience than that ! Anyway, as I have mentioned before, but it will bear repeating to new readers, cut the slots in the blanks first, and then cut out the link around the slot. This sounds at first, like building a barrel around the bunghole ; but if you spoil a slot, it is only a matter of getting another blank and having another shot. If you had cut out a nicely-shaped link, and then spoiled the slot, it would mean a great waste of valuable time, not to mention a probable cataract of railroad Esperanto.

The best material from which to make the links, is the stuff mentioned above (gauge steel, or ground flat stock) which is a fine grade of cast steel, and can be hardened and tempered readily. Two pieces are needed, $1\frac{3}{4}$ in. long, $\frac{5}{8}$ in. wide, and $\frac{1}{8}$ in. thick. Mark the outline of the expansion-link on each ; then, on the centre-line of the slot, drill a row of 5/32-in. or No. 21 holes, practically touching. Run them into a slot by aid of a rat-tail file : then, with a small half-round file, clean up the ragged sides of the slot until a piece of $\frac{3}{16}$-in. round silver-steel can be

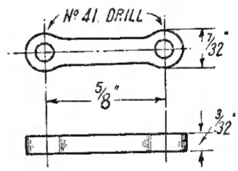
the side view. Instead of the bottom of combination-lever, and main crosshead drop-arm, entering slots, one of the separate links is put at each side of the lever and arm, and the whole bolted together.

Expansion-links

The expansion-links are a little more tricky, but there is nothing at all to scare any beginner.



Radius-rod



Lifting-link

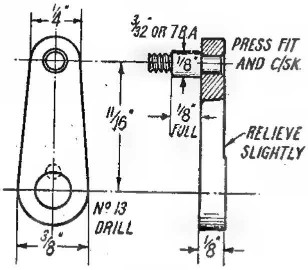
The slots *can* be machined, but require a special gadget rigged up, unless you have a drilling-and-milling spindle for the slide-rest of the lathe. If you have, it is a safe bet you will know how to use it ; so all I need say on the subject is that the two link blanks (pieces of ground flat stock, as the steel for gauge-making is known in the trade) should be soldered to a piece of stout brass plate, and bolted to the lathe faceplate at a radius of $2\frac{1}{8}$ in. from centre of mandrel to centre of blanks. Then a $\frac{3}{16}$-in. end-mill, or home-made

run from top to bottom of the slot without binding anywhere, and without shake. It isn't as difficult as it may sound ; the job just requires a little care, that is all. The ends of the slot can be squared with a small square file. When the slots are O.K. it is an easy job to file the outline of the link around them, and drill the hole in the tail. The dieblocks can be filed up from small pieces of the same kind of material, to the dimensions given in the illustration. The curved surfaces at each side, should correspond with the

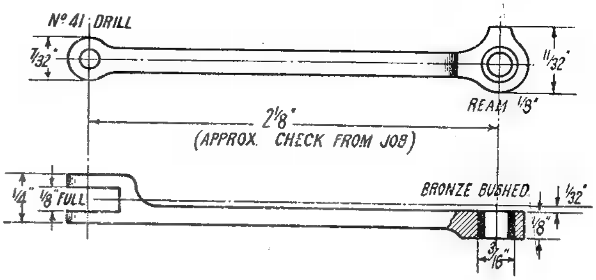
curved surfaces of the link slots, and the die-blocks should slide easily from top to bottom of the links, freely but without shake.

The yokes are made from mild-steel of ¼ in. by ⅜ in. section; get a piece long enough to clamp under the slide-rest tool holder, and square off the ends in the four-jaw. Mill out each end similar to the jaws of the crosshead fork, ¼ in. full width, and ⅜ in. depth; this is where the long piece comes in handy, as it is easier to clamp under the slide-rest tool-holder. At the bottom of each jaw, and plumb in the middle, mill out a little recess 1/16 in. deep, and a bare ⅛ in. wide, so that the expansion-link will jam tightly into it. Part off each yoke ½ in. from the end. Jam the tongue at the back of the link, tightly into the little recess, and braze it. Just smear a little wet flux at each side of the link, blow up to bright red, and touch the joint with a bit of thin brass wire. Use only very little, or you will have the stuff running all over the link and yoke. Quench out in clean cold water before the redness dies away, and the link will be rendered hard enough to resist wear. The dieblocks can be hardened in a similar manner, at the same time.

On each side of each yoke, exactly opposite the centre of the link slot, make a centre-pop; drill No. 40, and tap 5-B.A., using a taper tap, and leaving the threads a shade on the small side. Put a few threads on each end of two pieces of ⅛-in. round silver-steel, and screw them very tightly into the holes in the side of the yoke. File off flush, any threads projecting into the space between the jaws; saw off the outsides to a shade over ⅛ in., chuck one in three-jaw, and face off the other to a bare ⅛ in. length, chamfering slightly. Reverse in chuck, and give the other trunnion a dose of the same medicine. The two trunnions should be exactly in line. The complete link should be perfectly clean and smooth, especially inside the slot.



Return-crank



Eccentric-rod

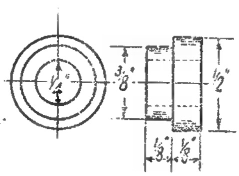
Radius-rods and Lifting-links

The radius-rods each need a piece of ¼-in. square mild-steel approximately 2½ in. long; and as they are machined exactly the same as the combination-levers, there is no need for repeating details. Each one carries a pin for accommodating the lower ends of the lifting-links. Countersink one end of the middle hole a little, and after squeezing in a pin made from 3/32-in. silver-steel as shown, rivet over the end into the countersink, and file off flush.

The lifting-links are merely pieces of ¼-in. by 3/32-in. strip mild-steel, ⅞ in. full length, drilled and filed to shape shown. The eyes should be case-hardened, as previously described. Put one end of each, over the pin in the radius-rod; the eye should be an exact fit on the pin; it *will* be, if the No. 41 drill makes a hole of correct size. Rivet over the end of the pin just sufficiently to stop the link from slipping off, but leave it perfectly free to swing. Only one lifting-link can be used on each radius-rod, as there is no room on the other side, owing to the proximity of the guide-bar and crosshead; see plan view of complete assembly.

Return-cranks

The return-cranks are made from pieces of ⅛-in. by ⅜-in. mild steel a full 1 in. long; another plain filing job. The big hole should be a squeeze fit on the end of the main crankpin. Drill the little hole 3/32 in. or No. 42, and countersink it; this side should be relieved slightly, as shown. Turn a little crankpin from ⅛-in. silver-steel, same as the main crankpins; one end is squeezed into the return crank, riveted over and filed flush whilst the other end is screwed for a nut, to prevent the end of the eccentric-rod slipping off.



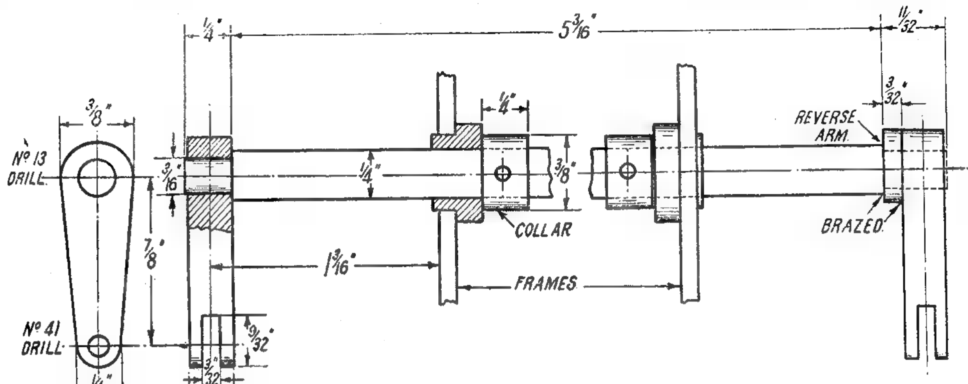
Reverse shaft bearing

The return-cranks are pressed on to the ends of the main crankpins in the position shown in the view of the complete valve-gear, in the previous instalment. Just set them "by eye" for the time being; final adjustment will be made when erecting the gear.

Reverse Shaft Bearings

At ¼ in. from the top of the frame at each side, and 5/16 in. to the rear of the vertical centre-line of the leading axle, drill a No. 30 hole in each frame. Put a piece of ⅛-in. silver-steel through it; if the steel lies square and level across the frame, enlarge the holes with 23/64-in. drill, and poke

a $\frac{3}{8}$-in. reamer through each. If the test bit of steel isn't square or level, true up the holes with [redacted] file, and try again with [redacted] bigger bit of steel. I usually give the position of the holes for the reverse-shaft bearings, on the main frame drawings; but in the present instance I wasn't quite certain where it would eventually be.



Reverse or weighbar shaft assembly

Chuck a bit of $\frac{1}{2}$-in. round bronze or gunmetal in three-jaw; face the end, centre, and drill down about $\frac{5}{16}$ in. depth with 15/64-in. or letter "C" drill. Turn down $\frac{1}{8}$ in. of the outside, to [redacted] tight fit in the holes in the frame, and part off at a full $\frac{1}{8}$ in. from the shoulder. Reverse in chuck, skim the face off truly, and put [redacted] $\frac{1}{4}$ in. parallel reamer through. Put them in the holes in the frames, with the flanges on the inside.

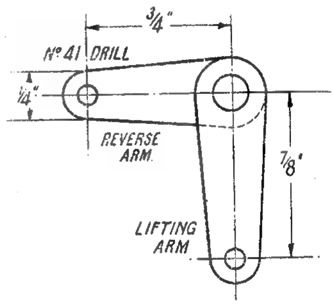
Reverse-shaft

Another simple job, this. A piece of $\frac{1}{4}$-in. round mild- or silver-steel, $5\frac{13}{16}$ in. long, will do the needful. Chuck in three-jaw, face the end, and turn down 11/32 in. length to a *full* $\frac{3}{16}$ in. diameter; reverse in chuck, face the other end, and turn that to $\frac{3}{16}$ in. *full* diameter for $\frac{1}{4}$ in. length. The distance between shoulders should be $5\frac{3}{8}$ in.

Two collars are required; chuck a bit of $\frac{3}{8}$-in. round steel, face, centre, and drill down about $\frac{3}{8}$ in. depth with a $\frac{1}{4}$-in. drill. Part off two $\frac{1}{4}$ in. lengths, and fit a 3/32-in. or 7-B.A. set-screw to each.

The lifting-arms are made from $\frac{1}{4}$-in. by $\frac{3}{8}$-in. steel. Take [redacted] piece about 3 in. long, mark off the arms on it at the ends, drill, slot out same [redacted] combination-lever and other slotted rods, saw to length, and file to shape. I have shown the arms only 7/32 in. thick, for the sake of neatness, but they can be left the full $\frac{1}{4}$ in. if you want to save work. The reverse-arm is cut from 3/32-in. by $\frac{3}{8}$-in. mild-steel, and drilled [redacted] shown. Note: the $\frac{3}{16}$-in. holes in the larger ends of the reverse-[redacted] and lifting-arms, should be tight on the ends of the shaft, which was why I specified "full" turning.

Put the reverse-arm and one of the lifting-arms [redacted] the longer spigot of the shaft; set them at right-angles, and braze or silver-solder them, same as the expansion-link job. Be careful to get this right; with the longer spigot to your right, [redacted] shown in the illustration, and the slotted arm pointing towards you, the reverse-arm should be vertical, pointing skywards. Clean off all traces of the brazing job; then poke the other end of the shaft through the right-hand bearing in the frame, thread on the two collars between frames, and put the shaft through the other bearing, squeezing on the other lifting-arm, [redacted] parallel to the first one as you can set "by eye." Then adjust the collars against the bearings, [redacted] shown; make sure that the shaft projects an exactly equal amount each side of frame, and tighten the set-screws. A little hole can be drilled in the shaft, if you like, at the point where each set-screw touches, using No. 41 drill, and the set-screws screwed right down into them; or the collars may be pinned to the shaft.

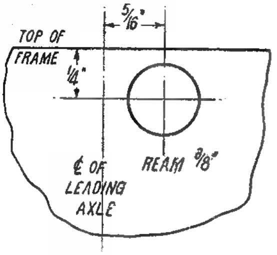


End view of reverse shaft

How to Assemble the Valve-gear

Note—the *pins* in the valve-gear are plain bits of silver-steel. The *bolts* are made from bits of silver-steel turned down [redacted] shade at each end, screwed, and furnished with nuts; so you'll know what I mean by "pin" or "bolt." Put the bottom of the combination-lever in the end

of the union-link drilled No. 43; squeeze a bit of 3/32-in. silver-steel through the lot, and file flush both sides. Put the eye of the radius-rod in the slotted end of the combination-lever opposite the lower hole, and pin that likewise. Don't forget that this has to be assembled right- and left-hand; the side of radius-rod carrying the lifting link, goes with the straight side of the combination lever. Put the die-block at the bottom of the expansion-link slot; pass the fork



Position of reserve shaft

of the radius-rod over it, drive [redacted] 3/32-in. silver-steel pin through the lot, and file flush each side. Take off the inner bearing of the link bracket, and the whole issue can then be put in place, as shown in the view of the complete gear in the previous instalment. The top of the combination-lever goes between the jaws of the valve fork, and is secured by a $\frac{1}{8}$-in. silver-steel bolt, made [redacted] described above, the ends being turned down to 3/32 in., and screwed 3/32 in. or 7-B.A. The loose end of the union-link is connected to the drop arm on the crosshead by a 3/32-in. bolt with 8-B.A. ends; the upper end of the lifting-links go between the jaws of the lifting-arms on the reverse-shaft, and are secured by similar bolts. Warning: the bolts should be free to turn with your fingers, when the nuts at both ends are hard up against the shoulders; this makes absolutely sure that the forks are not pinched in on the rods, causing binding and friction. Replace the inner link bearing, and we are ready to set the return-cranks and make the eccentric-rods to the correct length.

How to Set the Return-cranks Correctly

Put the main crank on front dead centre, with the piston-rod in as far as it will go. Set the expansion-link in such a position that the die-block may be run up and down the slot, without causing any movement of the valve spindle. Now, with a pair of dividers, take the measurement from the centre of hole in link tail, to the centre of the return-crank pin. Next, turn the wheels around until the crank is on back dead centre, but take care not to move the link. Apply the dividers again; if they still touch the centres of link tail hole and return-crank pin, the cranks are O.K. If they don't, shift the return-crank so that the pin moves *half* the difference, and carry out the test again. When the measurement tallies exactly with the crank on either of the centres, the return-cranks are correctly set, *and the distance between the divider points is the exact length of the eccentric-rod between pinhole centres.* The eccentric-rods can then be made from $\frac{3}{8}$-in. square steel, to the outlines shown, the measurements between holes being taken from the dividers. The link end has an off-set fork, same as the combination-lever; the other end is made like a weeny coupling-rod end boss, as shown. Drill the boss $\frac{3}{16}$ in., and squeeze in a little bush turned from bronze rod; this is reamed $\frac{1}{8}$ in., and should be an exact fit on the return-crank pin. Secure that end with an ordinary commercial nut and washer, and put another 3/32-in. bolt through the forked end and the link tail.

If the gear has been made and assembled correctly, the wheels should turn freely, and the whole of the motion work should operate sweetly without any signs of binding; at the same time, it should have no slackness. The engine should reverse readily; no matter what the position of the links, the die-blocks should run freely up and down, when the reverse-arm is operated. To prevent any movement of the return-cranks, and upsetting the valve operations, drill a No. 48 hole half in the crank, and half in the crankpin, as shown by the dotted circle in the drawing; tap 3/32 in. or 5-B.A., screw in a stub of 3/32-in. silver-steel, threaded to suit, and file off flush. We will leave the actual valve setting until the reversing lever is made and fitted; the left-side lifting-arm can also be set to match the brazed one at the same time, and pinned to the shaft, as it is essential that both die-blocks occupy exactly similar positions in their respective links at all times. I have seen more than one expensive commercial or professional job in which, with the lever in mid-gear, one die-block was above centre, and the other below it—and some folk wonder why they get syncopated beats!

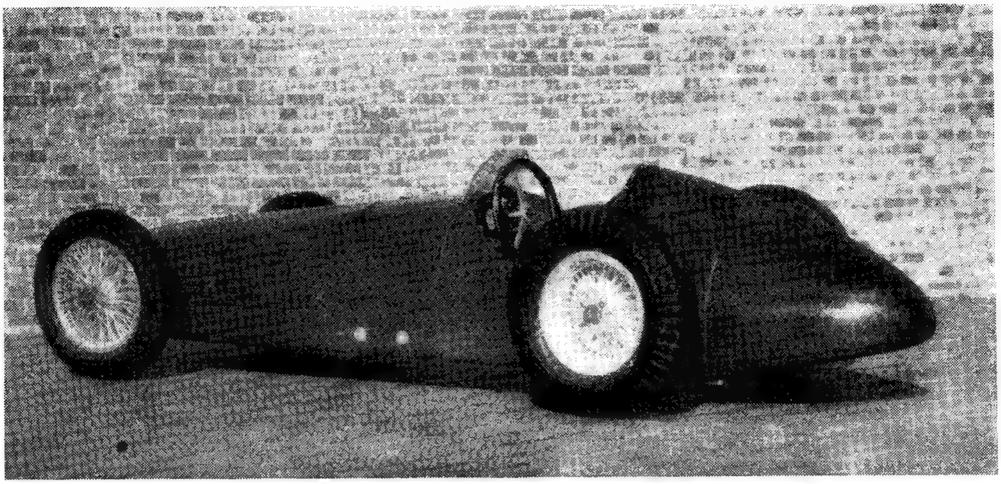
A Proposed Society for Keighley

MR. HARLAND BROWNLESS formerly hon. secretary of the Doncaster Model Engineering Society has written to let us know that he has been transferred to Keighley, Yorks. He is in the police force and therefore liable to periodic transfers to other districts. He was really sorry to leave the Doncaster society where he had made many contacts with members of other societies, in addition to those within his own society; so naturally, he misses the enjoyment of their company and activities.

He tells us that there is [redacted] society in Keighley, although there is [redacted] model engineering class, under the capable guidance of Mr. George Bass, a local engineer, at the Keighley Technical College.

But Mr. Brownless would like to see a society formed in his new home-town, where he is a stranger after 21 years in Doncaster, and he would be glad to hear from any enthusiasts in Keighley. His address is 159, Redcliffe Street, Keighley. We would add that he won [redacted] Bronze Medal with his Brooke Marine Cruiser at the "M.E." Exhibition in 1948.

MODEL CAR NEWS



The "B.R.M.", Britain's Formula 1 racing car, is of $1\frac{1}{2}$-litre capacity, its 16 cylinders developing over 400 b.h.p., and it is potentially capable of breaking all existing European circuit records. *Now turn to page 550*

Here and There

by "Clubhound"

IT sure is queer how news gets around these days. Word has come in from many sources that the American bug is biting pretty hard in model car circles and even our most successful "build your own" motorist seems to be suffering from the epidemic. What about it, F.G.B.?

I am glad to hear, however, of several purely British efforts, and it would appear that Joe Riding, of Bolton, Ernie Jackson, of Derby and M.C.A. and one or two others will bear close watching during the fast-approaching season. Good luck, fellows!

Don't think, for a moment, that I am decrying the workmanship and results produced by our American cousins. I am too well aware of the excellence of their designs and their suitability for "sheer speed" events; but, surely, far more important than mere speed, is the depiction of the true racing machine in miniature, a point which I am sure will be agreed by an overwhelming majority of readers!

Dragging myself back to a safer topic, I understand that the picture of the G.P. Special in the issue of THE MODEL ENGINEER dated March 9th, caused quite a stir amongst the 2.5 c.c. fans. Looks like you've started something, Mr. Hart, and I hope she goes as well as she looks.

Talking of G.P. Specials, a little bird told me that Captain Stubbs, over in Germany, is getting on great guns with his version, which has been modified to incorporate a head-rest. Should present a nice appearance and we shall look forward to seeing photographs.

Had lunch at the Steering Wheel Club with Rex Hays the other day and was afforded the opportunity of a close scrutiny of the B.R.M. model, a description of which, I understand, is to be commenced in this issue. Great credit is due to this well-known modeller for his very fine efforts on Britain's latest, which Leslie Johnson assured me was as near the real thing as any model possibly could be. Coming from so famous an international driver, that statement really is something!

I hear that the fortnightly "get-togethers" of the Pioneer M.R.C.C. at a location in Poland Street are a great success, offering as they do an opportunity for members to exchange views and ideas on the many aspects of the game in a leisurely manner. Here is an idea that may well be followed by other clubs up and down the country, with greatly beneficial results.

By the way, rumblings have been heard in a certain district of late which, when analysed, seem to boil down to only one source—a hot jet motor. Coupled with this is another rumour, that—er—so sorry, I've temporarily forgotten his name—is preparing a sleek projectile to attack the "World Miniature Land Speed Record!" He won't confirm it, so we'll just have to wait and see.

And lastly, here's something for some of you to guess about: Who are the organisers of the hush-hush "Dooling Club" and why are they keeping so well tucked away in the depths of mysticim and obscurity?

American Comment on Model Racing Cars

MR. H. W. FRANK, of New York, writes :—"I was indeed sorry to read in the February issue of *The Model Car News* that your excellent publication will cease to exist. In America we do not have such a magazine, as our race car publication contains only race meet results and has little space devoted to the technical matters.

However, for the past two years I have noted your many discussions regarding American and British engines and a few caustic remarks about the high speeds made on this side of the ocean.

Not Like Racing Cars

I will agree with you chaps that our cars do not look like actual racing cars, but you must keep in mind that we are only interested in speed and more speed. All our developing improvements are made to 'beat the other fellow,' a fact that causes plenty of discouragement on the part of the many fellows who do not have their own machine shops, or who cannot afford the high cost of the custom racing equipment put out by a few specialists.

Out of the approximately 300 tracks in the country, there are only about a dozen tracks on which records have been established. And out of the 3,000-4,000 cars running during 1949 only 30 of them officially went over 135 m.p.h. There are plenty of meets run on various tracks in which the winners do no better than 110 m.p.h. Not only do track surfaces and weather conditions affect the speeds, but also how many of the 'hot shots' were racing that day.

At the Nationals held in August at Indianapolis there were over 130 entries, and in the prototype class alone, the winner's speed was 138.10 m.p.h., the 20th car did 132.15 m.p.h., and the 45th car was clocked at 129.89 m.p.h. You can see by these results that competition can be very keen. In the Jacksonville Florida meet held February 25th and 26th the records for a quarter mile were broken with a spur-gear car at 142.85 m.p.h. and a proto (bevel gears) at 142.63 m.p.h.

Meetings

During 1949 there were over fifty sanctioned meets held for 10-c.c. cars, besides many unsanctioned races run by individual clubs, and also 'mite' class races for .19 and .29 engines (speeds 70-90 m.p.h.). Since space and publicity are limited, only the larger meets with the high speeds receive any recognisation, but the 'slow' fellows derive just as much enjoyment from the sport as the chaps that hold the records.

In your February issue you printed a short review of a meet between the Buffalo and Rochester clubs as an example of U.S.A. racing. I hardly think your selection of this meet is warranted, since you never beforehand published any other of our results. The above-mentioned race was not sanctioned by our national association, the track is far from being 'first class' and has never passed the safety requirements as established by the association. And a N.Y. State Regional Director I find only one participant was a member of the association. To illustrate that particular meet as an example of American racing is not in the best taste.

At a typical American meet, namely the International Championships, there were 93 entries including three from Sweden. This meet was sanctioned by the International Model Race Car Association and attracted entries from all over the country. No records were made, but the competition was very close.

We in America admire the workmanship of your cars and the efforts of your leaders to increase performance. The fact that you have so many model engineers building their own engines is to be highly commended. Your commercial engines have equal merit with our own stock engines, and in time should perform as well as ours.

Speeds

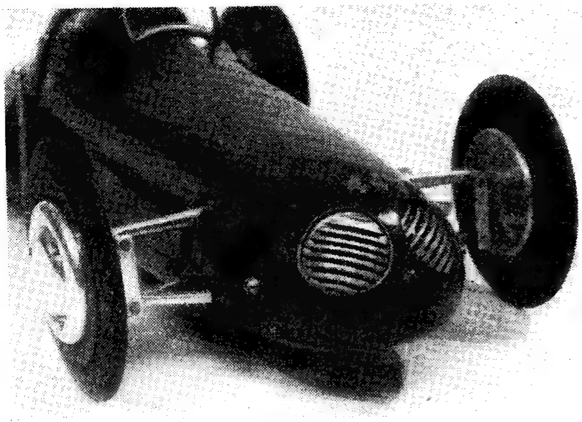
Possibly we have done more to develop higher speeds from present equipment than you have, but that is what makes one car faster than the other. An example of development is my own Dooling-powered Arrow car, which did a top speed of 117.95 m.p.h. in 1948 when it ran with a stock motor, gears, and tyres. In 1949 the engine was rebuilt with a chrome-plated liner, compression was increased, all ports and internal parts well polished, and using a gear ratio of 1.84 the speed was increased to 130.81 m.p.h. to hold the I.M.R.C.A. record for the class.

I think the question of fuel formulas is another reason for our high speeds, with some of the top cars in the country running on as high as 50 per cent. nitromethane. True, we burn up pistons frequently, but one must take reasonable chances to become a winner.

Some day I hope to see a British car run on our tracks under our racing conditions, and at the same time a few of our top cars running on your tracks. I frankly feel that when the results are compared the difference in speeds will not be very great.

May I wish you all continued success during the 1950 racing season."

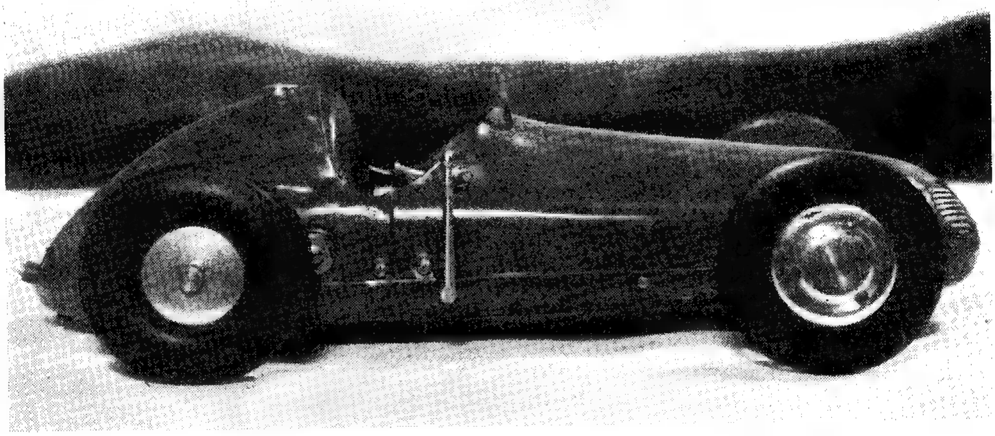
[We assure Mr. Frank that no bad taste was intended when we published the report on the Buffalo-Rochester meet in the February issue of *The Model Car News*. It was taken from the American publication *Model Race Cars* and comments relevant to the quality of the track are their own. The purpose of its inclusion was to convince a number of our readers that not *every* American car is faster than our British efforts. We would like to thank Mr. Frank for his heartening and very sportsmanlike comments.—ED., "M.E.".]



The Hart 2·5 c.c. G.P. Special

by G. W. Arthur-Brand

IN answer to countless requests for further pictures of this car (see the photograph published on page 322 in the March 9th issue) herewith is a selection of three which, I think, will enable the potential builder to get a perfectly clear idea, in conjunction, of course, with the drawings, of how things should appear from various angles.



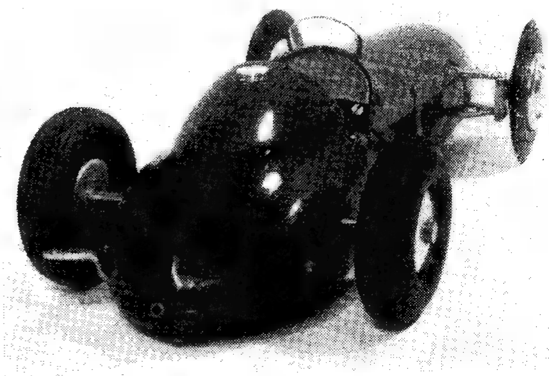
Mr. Hart has used an entirely different method of approach from the one adopted in the production of the prototype, but it has not in the least detracted from the handsomeness of the finished article.

In the top picture, it will be seen that the front suspension is exactly as per drawing, with the exception of the omission of the lightening holes in the axle bearer. The radiator grille is of different construction and set at the maker's angle.

It is rather a pity that no access panel was fitted, as this adds greatly to the realism of almost any model ; normal type wheels and rear view mirrors, too, would make a lot of difference, but as the owner is also hoping for a fairly high performance, he can hardly be criticised for these omissions ! Incidentally, readers will note that on this model it is possible to remove the body without dismantling the suspension.

The centre picture shows where the fuel cut-off switch is placed and how the body was constructed to be removable in two separate sections, fore and aft. The fuel filler can just be seen in the cockpit.

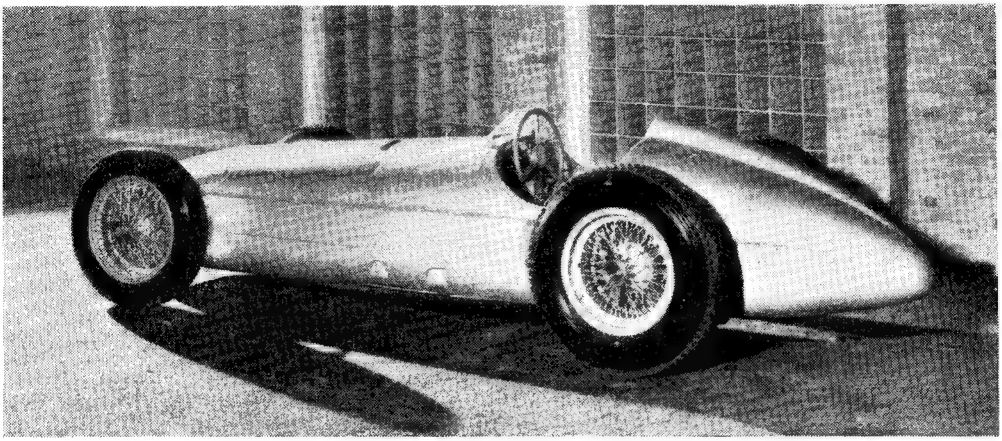
The lower three-quarter rear view shows a very neat finish on the reverse curves of the tail. The driving wheels are rather heavily tyred, but they are semi-pneumatic, very light and should compensate the lack of rear springing. The socket low down takes the + jack for the glow-plug connection, the — going to earth *via* the push-stick fork and the rear axle.



The "B.R.M."

It's Construction to 1/10th Scale

by Rex Hays



The photograph you looked at on page 547 was not of the full-sized car, depicted above, but a 1/10th scale model by Mr. Rex Hays, the building of which he describes specially for readers of THE MODEL ENGINEER *in this new series*

IT has been 26 years since a team of British racing cars were designed to the existing Grand Prix formula of the day to carry British racing colours in continental events. In 1924 it was the 2-litre Sunbeams, and today it is the B.R.M. In 1924, I built the first model of the 2-litre G.P. Sunbeam, and during the past months I have been anxiously reading progress reports on the B.R.M., and waiting for the day when sufficient information was available to start work on this somewhat mysterious and, by all accounts, phenomenal vehicle.

Last December certain information was released together with a quite good assortment of photographs—information which I felt was sufficient from which to build a really accurate 1/10 scale model.

This information included certain dimensional data, and just in case any enthusiast, anxious to build a model of this car in its present form, missed the copies of the motoring journals which published them, here they are :—

Wheelbase	8 ft. 2 in.
Track front	4 ft. 4 in.
Track rear	4 ft. 3 in.
Height of scuttle from ground	30¾ in.
Height of head fairing—highest point on the car	34 in.
Front wheel in tyre size	5.25 × 18
Rear wheel in tyre size	7.00 × 17
Brake drums	14 in.
Ground clearance	4.75 in. approx.

The above data, when applied to a drawing board, gave the 100 per cent. accuracy at a number of key points—wheelbase—track—tyre size—body heights in two places, and brake drum dimensions. The ground clearance subtracted from the given height of the body from the ground at the scuttle and the head fairing, gave the depth of the body itself at these two points with complete accuracy.

A close study of all the available photographs plus a confirmatory phone call, established that the point of the tail was on a direct line with the lower edge of the rear wheel hubs, the top of the body having a greater curve downwards than the underside's upward tilt. Experiments on the drawing board soon began to produce results; results, moreover which I always find ideal in the establishing of the correct outlines, namely, that the upper and lower curves of the tail when joined at an accurately estimated or known point, will automatically decide the length of the tail, provided the degree of sharpness or bluntness of the extremity of the tail can be determined. This situation creates a counter-check as, if upon study it is found that, for example, the vertical join in the tail is in the wrong place relative to the rear wheels and as a result the tail appears too long or too short, the fault will be in the top or lower outline of the tail, and it is only a matter of time and experiment on the drawing board to achieve something very close indeed to 100 per cent. accuracy, both in tail length and outline.

Turning to the front end, I looked for some guide which would lead to strict accuracy and I found it in two places again—the ideal state of

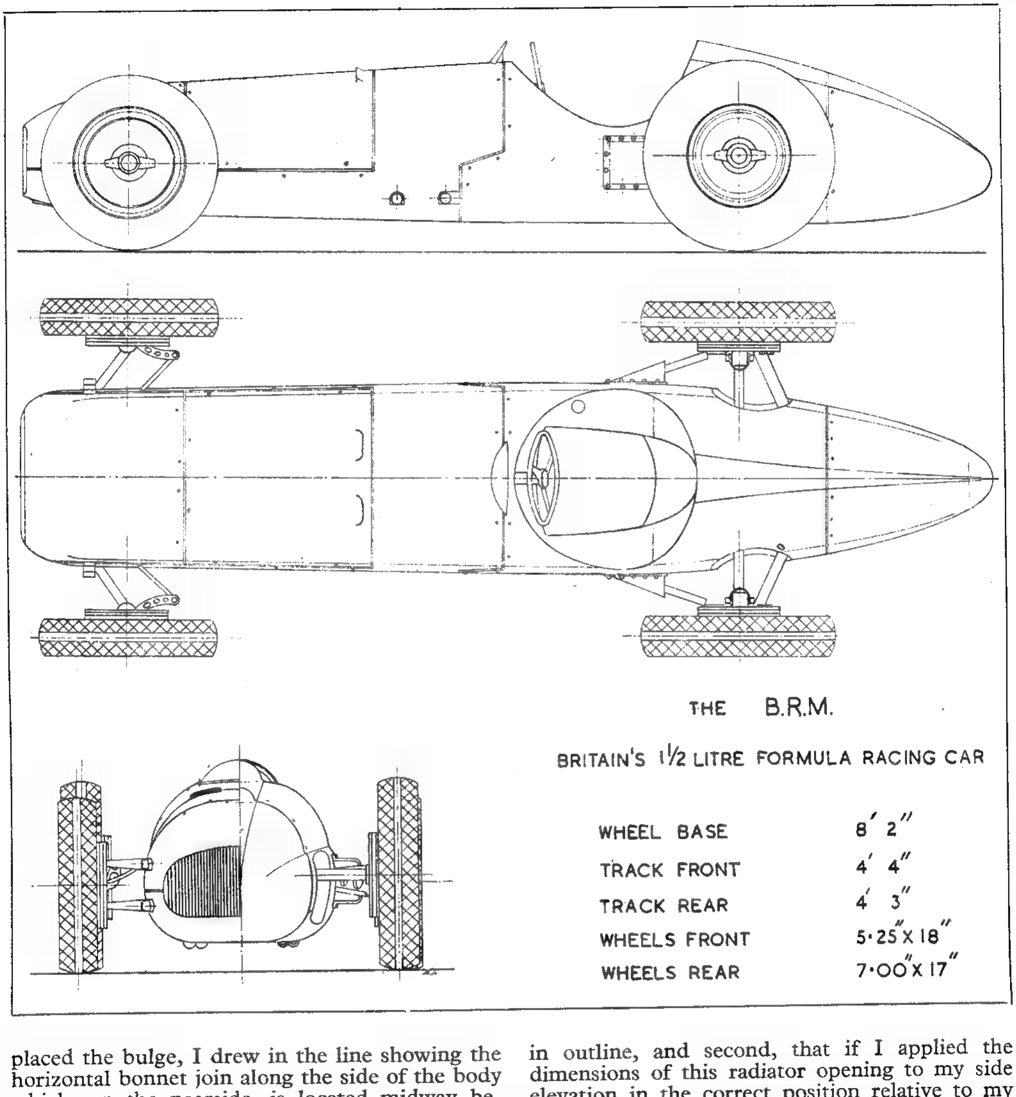
affairs as they could both be checked one against the other.

First, I established on the body sides the position of the faint bulge or step by means of photographs relating the position to the wheel centres, taking into account the angle from which the photographs were taken; a further check on this was to come later. Having tentatively placed the bulge, I drew in the line showing the horizontal bonnet join along the side of the body which, on the nearside, is located midway between the top of the bulge and the underside of the car. This line is continued along the body as far forward as the radiator cowling, and is located just below the wheel centres. Incidentally, on the offside of the car, this join is located from the radiator cowling back to the vertical front bonnet join, the horizontal join being much higher up on the line of the bulge.

Secondly, I had by me a close-up photograph of the nose of the car, showing the radiator cowling and making clear the point between the top and bottom of the grille where it was met by the extended bonnet join.

By a stroke of luck the photograph was almost exactly to 1/10 scale. This was fortunate in two ways—first in that it meant that the radiator cowling and grille would be 100 per cent. accurate in outline, and second, that if I applied the dimensions of this radiator opening to my side elevation in the correct position relative to my estimated and extended horizontal bonnet join, the whole front end would either fall together like a jig-saw puzzle, or else some inaccuracy would have crept in. (Front end.)

Well, it all fitted in perfectly, and I was only left with the joining of the top and underside of the radiator cowling to the scuttle, both known dimensions from the ground. Not entirely satisfied, I further confirmed the accuracy of this



side elevation (especially in relation to the bulge), by ascertaining from an assortment of photographs the exact point at which the two trailing links of the front suspension emerged from the body, and found that it was at almost the exact point where the bulge blended into the rounded radiator cowling. As I have often found that two wrongs sometimes make a right, I made a further final check by transferring my side elevation drawing to stout card and cutting it out. Card discs of the front and rear wheel sizes were then made, and this silhouette mock-up was built up, the rear suspension protruding from the tail at the point which, by photograph, it appears to emerge in relation to the bulge, and the trailing links of the front suspension in the correct position on either side of the extended bonnet join as arrived at from the close-up photograph of the nose. Everything, including ground clearance and maximum body heights, was just right.

The plan view of the body was comparatively simple to arrive at, as, in the first place, it was known that the body width was maintained from the point at which the trailing links joined the body back to the cockpit. The width of the radiator was known from the photograph already referred to ; it was merely a question of balancing the track of the car and the angle of the trailing links, which were strictly related to the wheelbase in the side elevation and the point at which the indentation of the bulge blended into the radiator cowling, because that was the point at which the front suspension emerged from the body. Later, this planning automatically established the length of the trailing links, as the legal profession would have it, without a question of a doubt.

Body Sections

Finally, the body sections were dealt with. The sectional contours were taken at five points—(1) behind the radiator cowling, (2) in front of the scuttle, (3) in front of the cockpit, (4) behind the cockpit, and (5) at the joining of the tail.

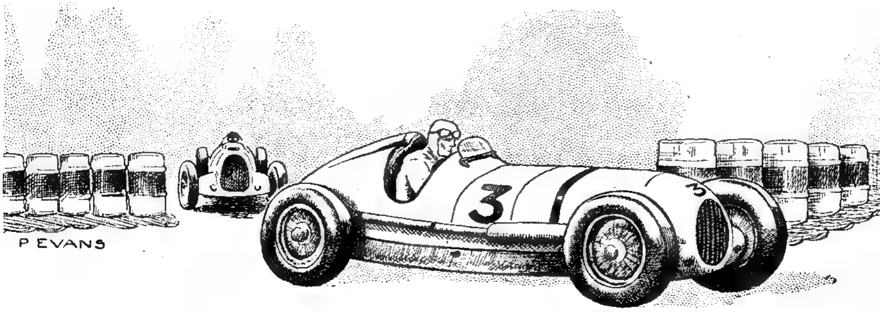
These bulkhead sections were formed by eye and calculation, in accordance with the dimensions allowable in both width and depth of the body. They were first cut out of stout cardboard, and fixed to a flat surface of wood, and an experimental body of drawing paper was formed and pinned into position. It was then possible to compare the mock-up result with all available photographs, and, if necessary, alter the radius of any body curve which appeared inaccurate. When every contour, after careful comparison, seemed dead right, the mock-up was taken apart and the bulkheads used as templates for the final construction.

This operation in itself served as a further check on the width and depth of the body design, as if any errors had crept in, no amount of playing around would make the contours right.

The degree of accuracy that can be achieved by this method of relating known dimensions to estimated dimensions, checking the result with a further known dimension, plus a somewhat elaborate system I have for calculating the exact distance from the ground the camera lens is located when the full-size photographs are taken, is best appreciated by the three-quarter rear view photograph of the model. Check it in every detail against the photograph of the actual car in the same position, noting especially the relative position of the join in the tail to both back wheels, the position of the nearside rear wheel relative to the steering wheel and surrounding bodywork, the position of the louvre relative to the offside front wheel the point at which the nose of the car disappears relative to both front wheels and the location of the front vertical bonnet join relative to both front wheels.

Except for the colour—the model is British racing green—the two photographs appear absolutely identical.

(To be continued)



The Model Car Association

THE annual general meeting was held at Derby early this year, when the following officers were re-elected: Chairman, J. Gascoigne; Vice-Chairman, F. G. Buck; Hon. Secretary and Treasurer, G. E. Jackson.

The hon. secretary reported that thirty-six clubs were now affiliated to the Association.

The new constitution was approved after some small alterations had been agreed.

Club secretaries should note that in future a list of members' names must be enclosed with affiliation fees.

Some time was spent on the question of an exchange of visits between Sweden and England, and as those who took part in 1949 found the trip expensive, the Association decided to seek means of assisting future teams' expenses. It was agreed that donations to an international fund shall be invited from affiliated clubs, who might make collections from spectators on race-days. It is felt that the appeal of these foreign visits would be considerably broadened, if some financial assistance could be given to those taking part.

Much time was spent by the meeting on discussion of the porposal by the Meteor and Bolton clubs, that at all events under Association rules, the 10-c.c. class should be sub-divided into British and open classes. Both proposals were defeated, but the Association decided to issue the following recommendation.

"That where possible, at future open events, the 10-c.c. class should be run in two sections, with prizes for both British and Open cars."

It is hoped, at an early date, to make available to affiliated clubs an approved speed chart which will be accurate to 1/100th of a second.

The hon. secretary has opened negotiations with our Swedish friends, for an exchange of visits during 1950.

The Sutton Trophy for home-built cars of up to 5-c.c. will be competed for at Eaton Bray on July 18th.

Open events will be held at Hooton on the following dates:—

June 11th. Lady Mary Grosvenor Cup for 5-c.c. cars.

July 30th. Open All Classes Meeting.

September 10th. *Daily Dispatch* Cup. Open.

Racing cables can be obtained from the hon. secretary at the following prices: 2.5-c.c., 3s. 6d.; 10-c.c., 5s. 2d., plus postage.

Hon. Secretary: G. E. JACKSON, Lime Grove, Chaddesden, Derby.

World Championship Race—1949

	Owner	*Make Car*	*Make Engine*	*Qual. Speed*	*Finals*
		Custom Proto			
1.	Bob Loose	Challenger	Dooling	136.77	136.77
2.	E. L. Luke	Challenger	L.S.	135.54	135.33
3.	Joe Ilg, Jr.	Ilg-Proto	Ilg-Dooling	135.13	134.32
4.	Bill Masonheimer	Ilg-Proto	Ilg-Dooling	135.13	133.72
5.	Eddie Anders	Ivey	Special	Cons.	133.53
6.	Cliff Fox	Fox	Dooling	132.74	133.33
		Manufactured Proto			
1.	Howard Frank	Arrow	Ilg-Dooling	128.93	128.57
2.	Walter Bender	Arrow	Dooling	126.40	126.22
3.	Johnny Lutz	Arrow	Dooling	127.84	125.00
4.	Bert Torrey	Invader	McCoy	Cons.	125.00
5.	Paul Bond	Arrow	Dooling	Cons.	123.96
6.	Lester Heft	Arrow	Dooling	124.82	123.62
		Spur Gear			
1.	Howard Frank	Own	Ilg-Dooling	134.93	135.13
2.	Stan Prussian	Borden	Dooling	Cons.	134.93
3.	Eddie Anders	Coffield	Special	135.74	134.32
4.	John Mayhew	Own	Dooling	132.74	131.57
5.	Howard Fox	Question	Dooling	Cons.	131.57
6.	Remez Team	Borden	Rem-Dooling	132.35	N.T.
		Hot Rod			
1.	Thomas Melahn	McCoy	McCoy	100.55	99.22
2.	Mike Bobko	Own	McCoy	106.00	96.87

Qualifying speeds made on Saturday, September 17th. All ties were run off, results as listed.

Foreign Entry Results

1.	Bernt Nilsson	Sweden	Mfg. Proto	121.13
2.	Aukie Erickson	Sweden	Mfg. Proto	119.04
3.	Eric Thorpman	Sweden	Spur Gear	89.10

Novices' Corner

Notes on Filing

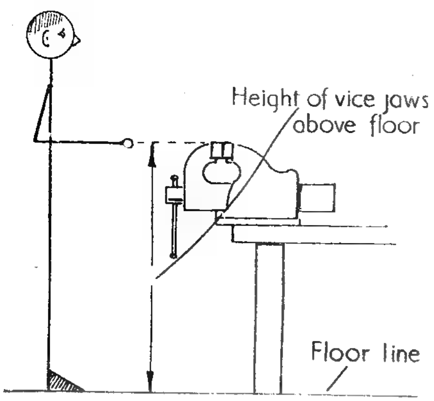


Fig. 1. Setting the vice at the correct height

THE technique of filing is by no means the easiest the novice must master if he is to be able to carry out with confidence the various filing operations he will encounter from time to time.

Success in filing is primarily a matter of the correct stance and arm action, but as it is also dependent upon fixing the vice at the right height from the ground this point will be considered at the outset.

To find this height, the person who is to use the vice should stand upright with his right forearm at right-angles to his body. A measurement taken from the elbow to the ground is the height at which the *top* of the vice jaws must be set. Or, to put the matter in a simple way, the top of the vice jaws should be level with the elbow when the forearm is extended, as shown in Fig. 1.

A vice set at this height is satisfactory for general purposes, but for fine filing it is an advantage to have the work at a somewhat greater height. This may most conveniently be achieved by mounting the work in an additional vice suitably clamped in the main vice. If this second vice is capable of swivelling so much the better, for this facility is a great help, as it allows the work to be presented at the most comfortable angle.

Fig 2 shows the right and wrong way to stand when filing. It will be seen that the left leg is placed in advance of the right, allowing the weight of the body to be applied to the file through the left arm and hand. Pressure applied in this way is necessary when removing metal as speedily as possible, but is not desirable when filing flat surfaces, for here the file must trace a truly horizontal path. This can only be ensured by imparting the necessary movement with the right arm swinging from the shoulder whilst the fingers of the left hand keep the file in contact with the work, as shown diagrammatically in Fig. 3.

From this illustration it will be seen that the right elbow traces a curved path as represented by the dotted lines, and that in order to keep the file on a truly horizontal course, the angle formed at the elbow joint must be opened as the file is pushed forward.

When filing flat surfaces it is essential that the file used should be of adequate length, that is approximately twice as long as the material being filed. Use a smooth, flat file as this will cut quite fast enough and, at the same time, give a good finish to the work.

When filing a flat surface always work in the direction of its greatest length as the more of the file's surface there is in contact with the work the easier it is to maintain the file on a truly horizontal course. Beginners often find this difficult for they tend to transfer pressure alternately to each end of the file with the result that, due to the rocking action, a convex and not a flat surface is produced.

In order to accustom himself to the proper movement, the beginner should take a piece of bright mild-steel stock some 5 in. to 6 in. long, grip it in the vice with its surface projecting above the jaws and lay a smooth, flat file upon it so that the latter balances. To guide it, the

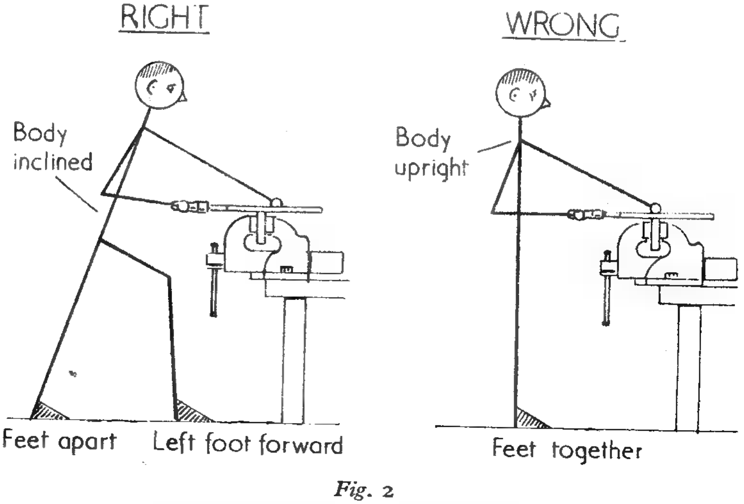


Fig. 2

fingers of the left hand are then brought into contact with the upper surface of the file at its farther end whilst the right hand grips the handle and moves the file backwards and forwards across the work in contact with the whole surface. If no undue pressure is applied and the file is allowed to cut by its own weight the beginner will soon find that he is developing the correct movement which he should endeavour to use whenever it is desired to produce a flat surface. It must, however, be pointed out that on the return stroke all weight must be removed from the file or it will become blunted.

Do not apply undue pressure as this will cause pinning, which is the tendency, particularly with fine files, for the teeth to become clogged with particles of metal, and spoil the finish of the work. If the file does become clogged in this way it must be well wire-brushed, and any stubborn metal particles removed from the file by means of an old scriber or some similar sharp pointed tool.

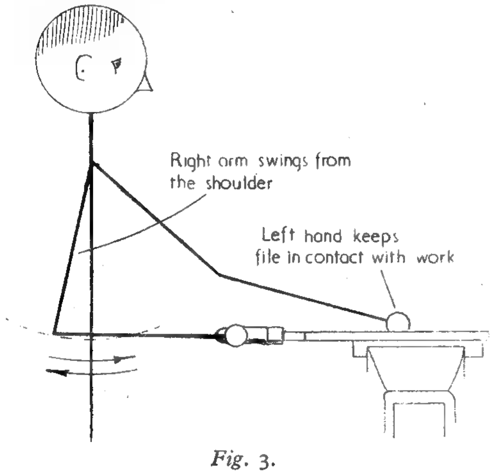


Fig. 3.

Some materials are more prone to pinning than others, but the difficulty can to some extent be overcome by either rubbing the working face of the file with chalk or by oiling it with a thin oil. Aluminium alloys are the greatest offenders and the removal of metal in bulk can only be satisfactorily accomplished by the use of special milling files which allow the filings to fall away without clogging the teeth of the file. These special files, the best known pattern of which is the "Dreadnought," do not produce a particularly pleasing finish. It is necessary, therefore, to use a well-oiled smooth, flat file to finish the work.

It is a mistake to use the same file both for brass and for steel. Brass needs a very keen file, whereas steel may be filed with one which appears to be worn out when applied to brass. It is a good plan to keep one set of files solely for brass and to mark them with yellow paint as a ready means of identification.

When filing long surfaces the file should be worked diagonally, first in one direction and then in the other, as shown in Fig. 4. By this means the progress of the work will be clearly seen, and, in addition, the work will be accelerated due to the relatively corrugated surface being repeatedly presented to the file at right-angles to its long axis. This is most noticeable when using a coarse file, for it will be found that the corrugations formed are quite appreciable, and that the

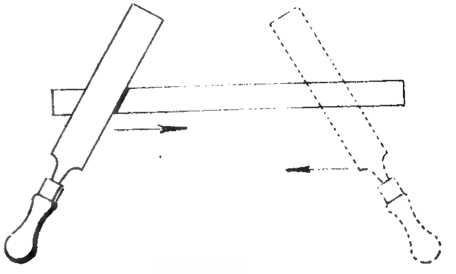


Fig. 4. *Filing long surfaces*

file tends to cling to them without removing much metal once they have been produced.

When large amounts of metal have to be removed the work should be attacked first on the near and then on the far corner. This reduces the area in contact with the file, moreover the parallelism of the faces so formed serves as an indication that the metal is being removed evenly. (Fig. 5.) Of course, wherever possible, the bulk of the metal should be removed with the hacksaw, prior to filing, and it is also essential that the work be first marked off to give guidance for both the filing and sawing operations.

Always grip the work with the surface to be filed as close to the vice jaws as possible. This is particularly important when thin material is being filed, otherwise an unpleasant screaming noise will result which is neither beneficial to one's own or the neighbour's comfort, and certainly contributes nothing to the success of the filing operation.

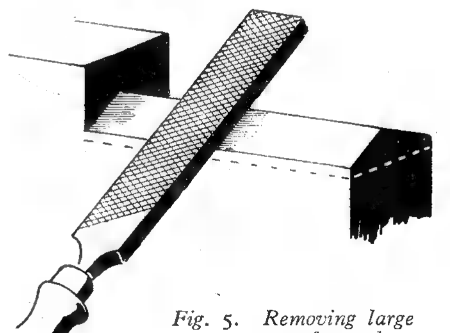


Fig. 5. *Removing large amounts of metal*

The beginner will have observed that the faces of the vice jaws are provided with teeth, similar to those on the file itself, to help them to grip. Whilst rough material may be held in the vice unprotected, any finished surfaces must have strips of copper or card interposed to prevent the finish being spoilt.

*TWIN SISTERS

by J. I. Austen-Walton

Two 5-in. gauge locomotives, exactly alike externally, but very different internally

NEXT to the correct finishing of the coupling-rod flutes comes the finishing of the outside profile. Strange, perhaps, that I should put this in second place, but there is a good reason for it. Because I am in the habit of thinking of the man who is not so experienced, and without very much machinery, I am also alive to the little mistakes he may make without even being aware of them. Thus, whilst holding the rods in the vice for working on the flutes, he may have damaged or marked the outside faces; not only that, the flutes may not have come out quite centrally with the main body of the rod, in which case he may trim the edges to suit.

Finishing the outside profile of the rod sounds very easy; yet, with a large number of engines I have been allowed or invited to examine, I have seen signs of rather shaky blending in of the radii that foregather in the area of the rod proper, and the eye and top lug provided mainly for oiler purposes—now don't tell me, let me guess. You say that when you use a round or half-round file for the sweep, that it has a tendency to remove metal below the straight portion with which it should blend, and that when you use the flat file to bring the flat portion down to the start of the curve, that it has a tendency to cut into the curved part with its edge—a sort of vicious circle. It all depends on the skill of the man with the file, and to certain little dodges that might be termed "secrets of the trade." If you do not mind working at the expense of good files, the old trick of holding the part of the work to be protected, down below the edge of the vice jaws—like a kind of universal filing jig, is as good as any. You can of course, use your good files to gain the approximate shape, changing to old files when there is little metal left to remove, and hardened vice-jaws cannot make them much worse. All this has been rather plainly in my mind since friend Duncan came to me last week, and said, "My coupling-rods have got toothache." They *had*, too; and then he told me the old story of the greedy files, and shaking with emotion, he handed me the offending parts. I dried his tears on a big clean white hanky, and told him about "stoning to a finish," (sounds rather like an advert. for something, doesn't it), and very simple it is too.

You remember I told you to get some slip-stones, some time ago—amongst them a few round specimens? Well, this is where you use them. If you have a drilling machine which will turn round at a fairly high speed—the modern, motorised versions will run up to about 8,000 r.p.m. and over—you will have all the necessary equipment in the way of machinery. Now take a round slip-stone of about $\frac{1}{4}$ in. or at a pinch $\frac{5}{16}$ in. diameter, and with a piece of thick brown paper or even shim brass wrapped round it, hold it in the chuck.

If the machine has, by design or accident, a hole in the platform, you can raise this until the stone goes through the hole a short way. Soak the stone in paraffin—most important is this—and switch on. By resting the coupling-rods flat on the table, you can work them round and against the revolving slip-stone, replenishing the slung-away paraffin with a brush from time to time. This method enables you to hold the rods firmly with both hands, and to see just where to remove metal, or reduce a nasty bump where it shouldn't be. The speed with which metal will be removed will depend mainly on three things: the turning speed of the stone, the pressure applied, and the grit and grade of the stone. Friend Duncan procured a fine grey carborundum stone of rather soft texture, and this did the job in fine style, and quite quickly. A word of warning to those who have not used such methods before, and that is—don't hang about in one place, nor in fact stop at all; the result will be another form of hollow, that, once formed, may be difficult to get out. The technique is to bring the work up to the stone in easy sweeping strokes, avoiding sharp corners rather carefully, and never putting on more pressure than necessary. It would be a good plan to practise on a piece of scrap metal first of all, until the simple knack has been acquired.

When next I saw friend Duncan, he was all smiles, and I thought I heard something that sounded like "wizard," or words to that effect; he produced the rods once more, revealing a flawless blending in of all the sweeps and radii, called for on the drawing, and a finished surface of that delightful dull grey, that is just right for motion work; no marks or scratches, no hump backs or blurred edges—a thoroughly well turned out job, in fact. You can, of course, use this method only for the rounded parts, finishing off the straight sections with a flat slip-stone, also soaked in paraffin and used like a draw file; the result is just the same, and, if anything, somewhat easier and quicker. The resulting edges may be as sharp as a knife, and, in such a case, I would advise you to draw a smooth stone or dead-smooth swiss file over the edge until it is safe to handle.

All this should have been carried out before the bushes were pressed in (sorry, my fault), and, just in case you have not done this job yet, it

*Continued from page 488, "M.E.," April 6, 1950.

would be as well to drill and tap the oil holes before the bushes are in. This enables you to drill and tap right through, which is always a blessing when working with small taps in hardish steel. Clean out the burr inside after tapping, and now squeeze in the bushes. The very tiny oil hole through the side of the bush may now be drilled, and it does not matter if this is not truly in line with the tapped hole in the rod itself—oil isn't very fussy about such things.

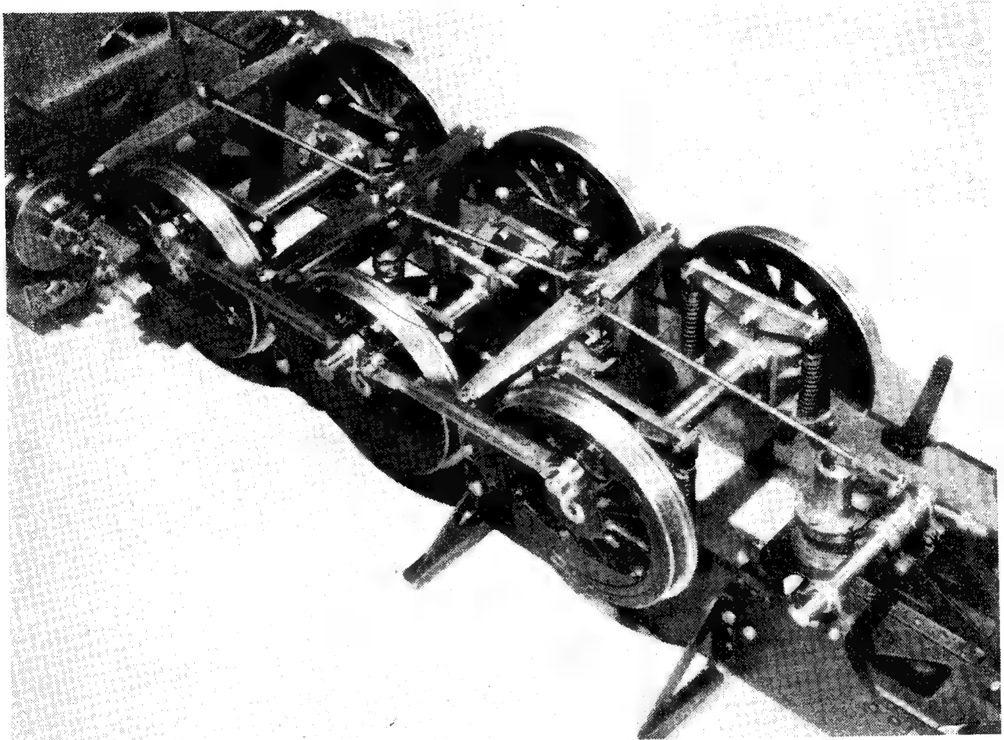


Photo by] *General view of wheels and running gear* [*H. Duncan*

Security Pegs

I have a feeling that this is an item that a number of builders will want to skip, but I sincerely hope not! The drawing tells you to put in screwed pegs; this means about 10 B.A., and with the tapped part in the bronze bush only. The object of this is to render future bush removal an easy matter; in the event of a new bush being required later on, it can be drilled out, removing the tapped parts of the pegs at the same time. The plain portions would be left in the eye of the rod, and could be knocked or pushed out, ready for replacement pegs. The screwed portion of the pegs should not go right through to the bearing surface, but just enough to gain a fair hold in the bush; otherwise, scoring of the crank journal might take place.

Hinge-pin

Having made, finished and fitted my own set of rods, I have been watchful of any point or tip that might be of use to other builders. That is where the concurrent building and description of an engine is of such help, and means more than any drawing or diagram. When I got to the hinge-pin, I found that a slight alteration would improve things. This is shown with a large flat head 1/32 in. thick. The diameter of this head is of little importance, but the thickness, although giving a theoretical clearance as it sweeps past the wheel crank face, may not work out so well in practice. I suggest reducing this still more, to 1/64 in., if possible, as it does not revolve and carries no end load at all; by "end load," I mean that there is no force exerted on it, tending to pull the head off the shank. Whilst doing this, reduce the head diameter to 3/8 in., and provide a couple of flats on it to give a slight spanner hold when tightening the nut on the other side.

Forked Joint

When this was finished and assembled, I had a feeling that its "universal joint" action was insufficient. I found that the free end of the trailing rod had a side waggle of about 3/32 in.; so I checked up on the trailing axle float, and found this to be enough to cope with side movement. In practice, it amounts to having a rather loose joint and nothing more, but without end-play. If you find you cannot get as much as

mentioned here, you can still further reduce the thickness of the male tongue of the fork to 7/64 in., leave plenty of strength in the joint and still provide the extra wobble required.

Spot-on Centres

And now a word of interest for the men with machines, and who like to have everything just exactly right. When I made my own frames, I reckoned that I had got my wheel centres in exactly the right places; that is, 4$\frac{3}{4}$ in. centres achieved by careful measurement, filing and fitting. This was all hand work, filing dead to a hair line, and checking with nothing more than a good steel rule with fine, clear markings. Even then, one expects to be the odd thousandth or so one way of the other, which, in this case, would not matter at all; it is when it mounts up to 1/64 in. or so that things begin to happen.

When I started on the coupling-rods, I thought it would be a good plan to check up on myself by jig-boring the eyes of the rods to within a single thousandth of the theoretical centres. I had a "Senior" milling machine of the latest type, and fitted with a vertical head, so I set about it in the following way.

First of all, I machined the driving eye socket of the coupling-rod assembly to its finished $\frac{9}{16}$-in. diameter. The 4$\frac{3}{4}$-in. centres were then marked off carefully on both sides, for the leading and trailing eyes, and these were drilled $\frac{7}{16}$-in. diameter, with an ordinary drill. A piece of brass rod was put in the lathe chuck, faced off, centred deeply, turned to a light drive fit in the $\frac{9}{16}$-in. driving eye, and parted off at the same setting—this was done for both rods. When these centred plugs were pressed in, the rods were clamped down, one at a time, on the milling-machine table, and with the clamps left fairly free. A No. 2 lathe centre was put in the vertical head, and the table raised until this picked up and sat in the centre in the brass plug; the clamp at this end was now tightened and the table traversed until the centre would sit in the $\frac{7}{16}$-in. hole exactly. It meant swinging the more or less free end of the rod until this was achieved, as it was now impossible to move the cross slide of the machine without altering the first setting. The other clamp was tightened, and the table travelled back to make sure that the first position was unaltered. Once more the centre was settled in the plug, and the thimble on the feed-screw set at zero after the thread backlash had been taken up. The table was now lowered, the centre removed, and a $\frac{1}{2}$-in. end-mill substituted. By winding the handle 23 times plus 150 on the thimble scale, I had travelled the work 4$\frac{3}{4}$ in. exactly. The table was now fed up to the end-mill which had to remove only the difference between $\frac{7}{16}$ in. and its own $\frac{1}{2}$ in. diameter. The fact that the end-mill might cut a hole a few thousandths more than its advertised size, did not matter at all, as the bushes had not been made at that stage.

When the rod assemblies were bushed and completed, the bushes were left a normal running fit for the crank pins. When the fateful moment came, I slipped on one set of rods (that is always the easy part) and turned the engine over on its back. The second set of rods dropped over the crank-pins just like a gauge. Now, *theoretically*, and without the wheels being in their exact running centres, it should not have been possible for the wheels to turn without a little binding or dragging at some points; but turn they did, no matter how the axles were depressed to give varying wheel centres, and never a trace of binding in any position.

There is a very definite lesson to be learned from this, and it is that, provided the wheel centres are just right, the quartering of the wheels done with more than usual care, and the centres of the coupling rods match the wheel centres to the same degree of accuracy, then the amount of slop necessary to avoid wheel binding is much over-estimated.

I have had so many requests from readers, for more pictures—particularly close-up views, that I include one with this issue. I have had nothing but praise for friend Duncan's photographic art, and well he deserves it. I would like some of you to see the trouble to which he goes in order to get the lighting and position just to his liking. He has an uncanny way of placing a view so that the parts requiring attention really do stand out, and do not look jumbled up with the background; and it is not nearly as easy as it looks. In this picture, I wanted him to give me a view of most of the brake gear, and with particular emphasis on the brake cylinder and brake shaft. I also suggested that the same picture might give readers some idea of how the pump yoke and eccentric looked when assembled, whilst an underneath view of the coupling rods would sort of round off the scheme. After the exchange of a few rude words, he got to work, with the result you now see.

Oilers

Once again, as the result of working on the spot, I feel that I can offer a "stop press" improvement of a slight nature. The drawing shows the oiler cups with hexagon heads against a plain round collar. The hexagon size is unstated, but can now be given as 0.15 in. across the flats, or 8-B.A. size. The drawing tells you to drill a $\frac{1}{8}$-in. hole by $\frac{1}{8}$ in. deep, to form the top cup of the fitting. This leaves a very thin wall for the hexagon part, and I felt it might get crushed or damaged by the spanner when putting it in. I think we might reduce the hole size to 3/32 in. and the depth to the same dimension.

The obvious way to make the oilers is to produce hexagon-headed nipples in the normal way, and to fit loose washers in the same material to go under the hex. head. They do not have to be taken out for oiling purposes, so there is not much danger of the washer part getting lost, and once assembled, it will look like one part.

Before screwing in the oilers for keeps, push into the tapped hole in the rod eye a small screw of wool, wadding or yarn; which will prevent dirt or grit falling into the bearing, and act as a reservoir for the oil. With fairly slack bearings as so often advocated, there is very little chance of any oil ever staying in the bearing for more than a few minutes, and the top wick of wool does keep a little back for future needs.

I am not going to be caught this time by saying that that completes the coupling-rod story, or somebody will be writing in to state a correction somewhere. I will content myself by saying that my own rods are on, the dimensions on the drawing are correct, but still further improved by the slight amendments given in this instalment, and that they work even better than I expected. Where I *do* expect trouble is in connection with the general proportions of the rods. The fact that they are made virtually to dead scale is sure to bring the question "Are they strong enough for really hard work?" I would have no hesitation in saying that, made in one of the high tensile steels such as stainless or cast steel, they will be stronger than mild-steel rods of nearly twice the weight.

My rods are made in steel of 45 tons tensile, which means that you could hang up a load of $1\frac{3}{4}$ tons on the end of the hanging-rod assembly before it would start to yield. Ordinary mild-steel varies from 15 to 18 tons tensile, according to quality and working, and much depends on that term "working." The steel used for making swords is not so wonderful, but the long processes of hand forging and heat treatment alters it out of all recognition, so that it acquires qualities that are quite out of the ordinary. Therefore, the ideal way of making small motion parts would be to forge them roughly to shape, and then machine them to finish, and, incidentally, leave much less metal to machine away.

(To be continued)

TRADE TOPICS

Multicraft 4-in-1 Hand Cutter

The many modellers who in the past have uttered profanity at the multiple cuts sustained through the use of double-sided razor blades may now relax!

Neat in appearance, of sturdy construction and with a pocket clip to ensure its "locatability," the Multicraft Precision Cutting Tool is sold with four blades packed away in a special screw-top compartment. They comprise: *M*1, for deep scoring, firm, solid cuts, erasing and cross cutting; *M*2, a general-purpose blade especially suitable for fine work on concave surfaces; *M*3, for sharp angles and deep cutting and *M*4, a versatile double-edged blade, ideal for whittling and for acute-angled corners.

The tool is made of lightweight aluminium alloy with a knurled collar for tightening the blade-locating collet. The hexagonal centre portion of the body prevents the tool rolling on to the floor when placed on a sloping bench or drawing board.

Particulars may be obtained from the distributors, Messrs. Phillips Omnipool Ltd., 29, Bolsover Street, London, W.1.

The "Grampus" All Square Welders Vice

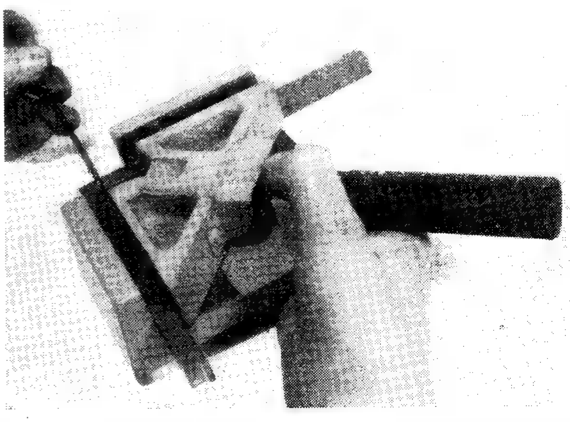
A useful addition to the model engineer's workshop came to hand recently in the form of a handy 6 lb. right-angular vice.

Designed primarily to set mitred angle, channel, "T" and "H" profiles, rounds, tubes and other sections accurately at right-angles to each other for welding, a number of other uses come to mind during examination.

It is made from close-grained cast-iron and so sonctructed that the heat from arc or flame can escape without unduly affecting the handle or the lock-screw, which is provided with a protective shield. All working surfaces are accurately machined and are relieved where necessary to accommodate materials which may be radiused.

Our illustration shows the vice being employed to hold two pieces of $\frac{1}{2}$-in. sq. material for welding.

Further particulars may be obtained from C. Casper & Co., 146-7, Grosvenor Road, London, S.W.1.

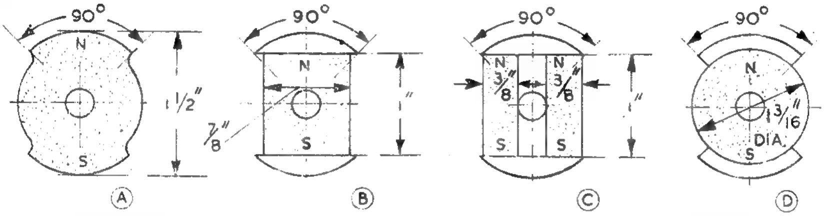


PETROL ENGINE TOPICS

*Modern Ignition Developments

by Edgar T. Westbury

WHILE the advantages of compression-ignition or glow plugs for certain specialised types of engines are beyond all dispute, the statement so often made publicly by those who ought to know better, that they are in all respects superior to the spark ignition petrol engine, is by no means correct. The fact is that these methods do not solve ignition problems; they simply enable them to be side-tracked in certain cases, where the sacrifice of flexibility and other characteristics of the normal type of engine is compensated by reduction of weight and elimination of accessories.



Examples of solid and built-up rotors; "A" solid cast magnet; "B," block magnet with pole-pieces; "C," two-bar magnet; "D," circular disc magnet

There has, indeed, been far too much talk of this or that established principle in model engineering being "superseded"; and like the report of Mark Twain's funeral, these pronouncements are often "grossly exaggerated"—not to say premature. When the compression-ignition engine first arrived, its virtues of high power per capacity, low weight and simplicity were extolled to such heights that the petrol engine apparently had no leg left to stand on. Then the glow plug came along, and according to several authorities, it immediately "superseded" the compression-ignition engine. In spite of this, however, spark ignition is still being used with success in several of the most efficient racing engines from 5 c.c. upwards.

The fact is that things are not so easily "superseded" as we are sometimes asked to believe, and the introduction and development of a new principle does not necessarily mean that everything which has gone before is automatically scrapped. Very often research in the progress of the new engine will provide a wealth of practical information which is applicable to the improvement of the older type. When the steam turbine was first introduced in an efficient form over fifty years ago, it was confidently predicted that the reciprocating engine, for marine and stationary work, was finished; yet such engines have survived and are still being built today. We have the diesel-electric and gas turbine locomotive now on the railways—but steam locomotives will be going strong for many a year yet!

I well remember attending a meeting about twenty years ago, when the development of the diesel engine for aircraft and road transport was very much in the limelight, and I heard an authority in the engineering trade state that within a year from that date the manufacture of petrol engines for these purposes would be abandoned in favour of oil engines. How false a prophecy that has proved to be!

In the field of industrial engineering, where the rule of the survival of the fittest must necessarily apply, there is much more likelihood of old principles becoming obsolete than in the model world, where interest is not necessarily centred entirely in utility or economics, and one can, in many cases, indulge in one's personal fancies and preferences. I am quite sure in my own mind that if model engineering consisted of nothing but chasing that elusive butterfly, high efficiency, it would soon lose its appeal to those who love engines and fine craftsmanship for their own sake. Far be it from me to discourage the quest of efficiency, which is an equally valuable and praiseworthy object, but let it take its proper place in the general scheme of things; it is not the be-all and end-all of the model engineer's existence.

Improving Spark Ignition

So far as the principles of spark ignition are concerned, these are so firmly established that there is little necessity, or indeed, possibility of improvement. Although there has been some research work done in recent years on electronic means of producing ignition sparks, it appears hardly likely that in the particular field with which we are concerned, these methods offer any advantages over the usual types of spark generators—namely, ignition coils and magnetos.

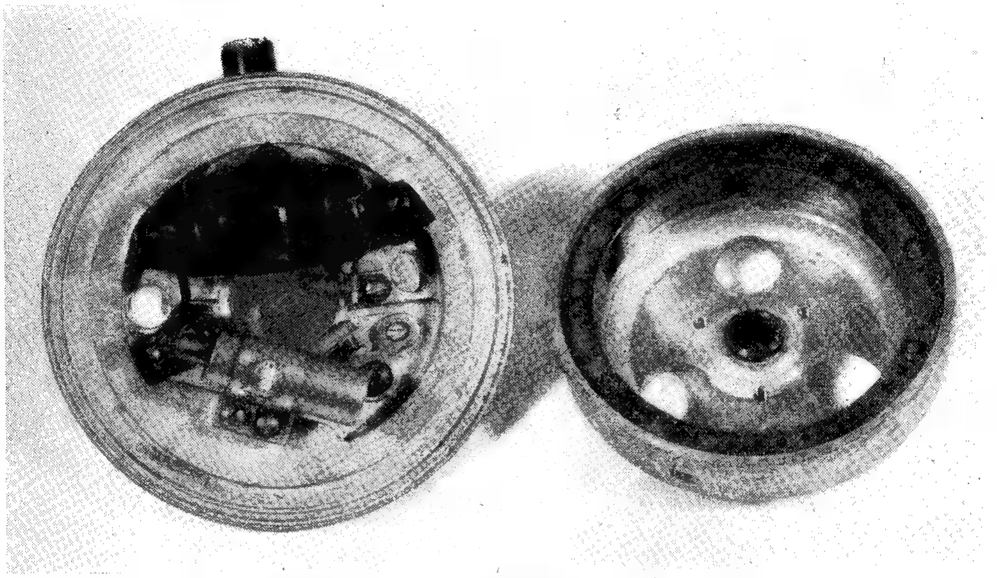
There are, however, possibilities of improving these considerably in detail, mainly in the

*Continued from page 466, "M.E.," April 6, 1950.

direction of greater reliability, which still leaves much to be desired. In the numerous queries received from readers regarding faults and troubles with model petrol engines, I am made painfully aware of the fact that ignition gear is often hopelessly inadequate, and is the source of at least 75 per cent. of engine failures. Very often the craze to cut down the size and weight of the ignition gear to the barest minimum destroys the margin of performance which is so essential to consistent success ; I am of the opinion that the popular ultra-lightweight coil, and even more so, the tiny dry battery, have done more to promote the cause of compression-ignition and glow plugs than that of spark ignition. Not that they are definite failures—it might have been better if they were, because they would have gone completely out of use—but they have so little margin of performance in hand that they only work when conditions are 100 per cent. perfect, which as every practical engineer knows, is not good enough. Many experienced users of petrol engines bewail the fact that nobody nowadays will trouble to produce the type of coil and battery which was used before the war, which gave complete reliability because it had a good margin of power in hand.

Some of the users of moderate duty engines, as used in prototype power boats, have reverted to the old trembler coil, which certainly gives a good spark efficiency, and also has the advantage of giving audible proof that it is working properly. These coils are of enormous size according to modern standards, and their weight, not to mention the space which they occupy, can only be tolerated in a fairly large installation ; neither are they suitable for really high-revving engines, but where flexibility and ease of handling are concerned there is much to be said in their favour. A few of these coils are still to be found in the dim and dusty recesses of the local junk shops, and can usually be obtained cheaply.

The reluctance of modern users of small engines to wind their own ignition coils, or undertake any other electrical construction work, makes it rather futile for me to give detailed instruction on this matter, but it may be mentioned that the subject was very completely dealt with in THE MODEL ENGINEER about five years ago, in a series of articles entitled " Ignition Equipment," and the bulk of the information therein is obtainable in the form of a handbook under the same title. In addition to ignition coils of all sizes and types, it describes how to construct miniature magnetos, which promote still further the reliability of the ignition equipment by the elimination of the battery, which is nearly always the weak link in the system.

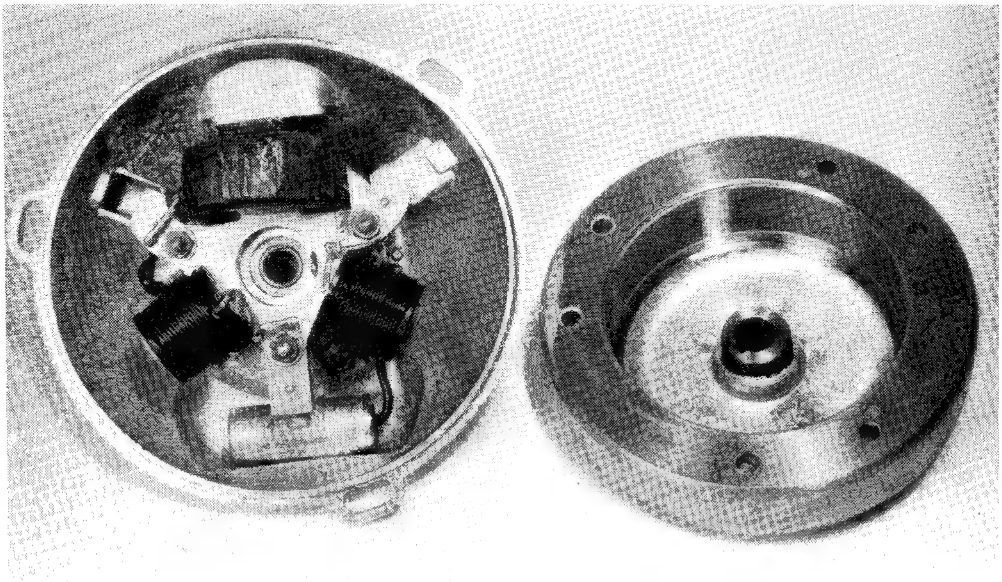


The Wico " Bantamag " lightweight flywheel magneto

It should be noted that in all my research work on ignition gear, I have kept very carefully in mind the requirements of the amateur constructor, and the coils and magnetos mentioned above are designed specially to suit the facilities of the worker with limited equipment and little knowledge of specialised electrical technique. Many readers who have followed my directions have found them work out with complete success, enabling them to produce a high-tension magneto which is at least equal in efficiency to a battery-coil system of equivalent weight. It would be quite possible to reduce the size and weight of the magneto without a great sacrifice of efficiency if one is skilful enough, and I have made several magnetos smaller than those described in " Ignition Equipment," but have not recommended them to the amateur constructor because of the greater problems involved in winding the very small coils.

Since the report of my work on magnetos was published, very tiny commercially made magnetos working on precisely the same principles have been made available in this country and abroad, and have been used with success both on high-efficiency and moderate-duty engines. The miniature magneto takes very little power to drive, and besides giving just as easy starting as a battery coil, gives added spark efficiency at high speed, where it is most needed; and the precise timing of the point at which ignition takes place enables maximum efficiency to be obtained with any type of fuel, without interfering with flexibility of engine control. In such ignition troubles as have been encountered, with magneto ignition, it has generally been found that the sparking plug is the worst offender, but the modern miniature plug is quite reliable if it is used with due discretion.

In recent years, I have carried out further detail research work on small magnetos, and some of the information obtained has been applied with practical success to the design of industrial miniature magnetos, as used on small auto-cycle and portable stationary engines. I have found little need to alter the essential features of the small magnetos described in "Ignition Equipment," such as the "Atomag Minor," except that some advantage has been obtained by detail improvement of the magnet construction. Both built-up and solid cast rotary magnets have been used, the latter (*A*) hvaing the advantage of maximum simplicity in construction, and they have been made available in a finished form to amateur constructors, by Messrs. Roox Products, of Alton, Hants, who also supply finished coils, laminations and other parts for building this type of magneto, either as a separate accessory or an integral part of the engine.



The Wico "Genimag" combined magneto and low-tension generator

The built-up magnet has a higher efficiency for a given weight of actual magnet steel, and is an advantage when using the most efficient forms of magnetic alloys. If the latter are used in the form of straight bars or blocks, ground true only at the ends, they are easier to obtain, and often cheaper, than castings which have to be individually ground to shape (these steels are too hard to be machined in any other way). Examples of built-up magnet rotors which have been successfully used in recent experiments are shown here. In view of the fact that the efficiency of the magnet (for a given type of steel) is largely determined by the *minimum* cross-section, the solid block type *B* shows the highest efficiency, but has the disadvantage that it is difficult to build up and mount, and the shaft cannot be carried through the rotor. The two-bar type *C* is much more convenient, and its efficiency is quite good enough for practical purposes. In type *D*, which was used in the original "Atomag Minor," the disadvantage of individual machining of the magnet still remains; this form was employed only because a suitable magnet was available at the time.

Although the magnet pole pieces should be made of laminated iron or high-permeability alloy, it has been found that solid iron or annealed mild-steel gives quite good results for pole pieces of constant polarity; this does not, however, apply to the stator poles, in which the polarity changes rapidly, and therefore laminations are essential. Other factors in the efficiency of small magnetos include keeping the air gap

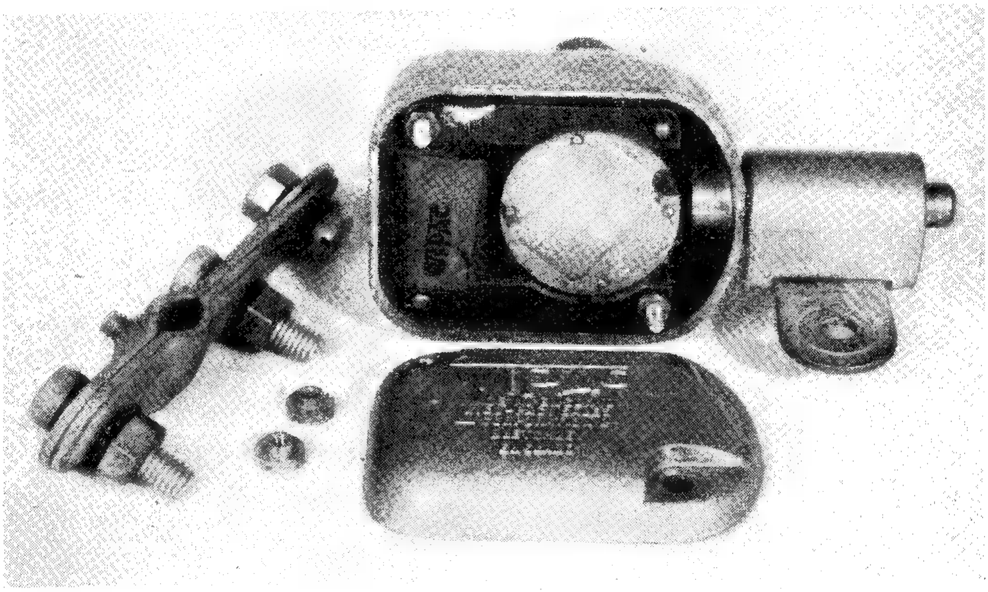
between rotor and stator as small as possible, and using a good design of rapid action contact-breaker with a suitable type and capacity of condenser across it. I am at present experimenting with a flywheel magneto embodying the essential features of the "Atomag," with due regard to keeping the design suitable for the amateur constructor, rather than designing it for commercial construction.

Progress in Industrial Magneto Design

I make no apologies for bringing in references to what—for want of a better term — must be described as "full-size" magneto production, because in this case the magnetos are of a small enough size to be definitely applicable to many purposes within the legitimate sphere of model engineering, and, moreover, embody some interesting features in their design. The magnetos illustrated are among the latest standard products of the Wico-Pacy organisation, whose up-to-date factory at Bletchley, Bucks, I recently had the privilege of visiting, and I was very much impressed not only with the progress which they have made in the development of ignition equipment in recent years, but also in the technique and production methods employed in manufacturing these magnetos.

The smallest magneto now in production is the "Bantamag," which weighs approximately 2 lb., half of which is actual flywheel weight, and the diameter over the removable sheet metal casing is $4\frac{1}{4}$ in. This type is intended particularly for use on the smallest sizes of engines in industrial production, such as auto-cycles and motor-assisted cycles, or for driving portable generating sets. It is the smallest unit of its kind which has ever been produced, and in view of the fact that it opens up completely new possibilities in the scope and application of such engines, it has created an enormous demand, both in this country and abroad.

The rotor of the magneto is die-cast and contains two magnets of high-efficiency magnet steel, with laminated pole pieces forming an unsymmetrical "three-pole" field, the essential working poles of which are spaced 120 degrees apart. An inserted steel hub is cast into the rotor centre, having a tapered bore which fits a $\frac{7}{16}$ in. shaft. Either a separate cam, or one machined directly on a shaft of enlarged diameter, can be used to operate the contact-breaker, which has a bakelite rocker arm and eccentric adjustment of the stationary contact. The coil is attached to the stationary backplate, and has a straight laminated core, disposed tangentially so as to span the angular distance between the working poles. In this way, a complete reversal of flux takes place in 120 degrees of rotor movement, the remaining 240 degrees being occupied idly so far as generation of the spark is concerned. By this method, maximum efficiency is assured over the small angular period occupied in the actual production of the spark, and low speed spark efficiency is also improved. Despite the small overall size of this magneto, not to mention the small bulk of the active magnet material and the true "ultra-miniature" coil, the practical results leave little to be desired.



The Wico cycle lighting dynamo

The second magneto, known as the "Genimag," is larger in size and is designed to suit the requirements of lightweight motor-cycles, which call for the generation of low-tension current for lighting, in addition to the

high-tension spark. It has long been possible to produce low-tension alternating current more or less efficiently from flywheel magnetos but there are obvious objections to direct lighting by this means, and the more usual method of providing a separate dynamo to supply direct current for charging the battery involves extra weight and expense. The "Genimag," in addition to being an efficient high-tension magneto and low-tension a.c. generator, can be used to charge batteries by the provision of [illegible] compact full-wave metal rectifier, and its current output under these conditions is sufficient to keep the battery charged at a high enough rate to cope with the requirements of [illegible] efficient lighting system.

The rotor of this machine is also die-cast, but in this case contains [illegible] cast-in system of magnets and laminated poles which produces [illegible] powerful symmetrical six-pole field. A six-armed laminated stator is mounted on the backplate, one pole of which carries the ignition coil, while two others equally spaced carry low-tension generating coils. The arrangement of the magneto is "inverted" relative to that of the "Bantamag," in the sense that the cupped side of the flywheel faces outwards, and the "backplate" is in this case a front casing, which in conjunction with an integral recess in the engine structure, forms [illegible] complete enclosure for the entire magneto. An inner recess in the centre of the magneto casing contains the contact-breaker assembly, which is thus readily accessible by the removal of [illegible] small sheet metal cover plate. The weight of this machine is $5\frac{3}{4}$ lb. including [illegible] 4 lb. flywheel, $5\frac{1}{8}$ in. diameter.

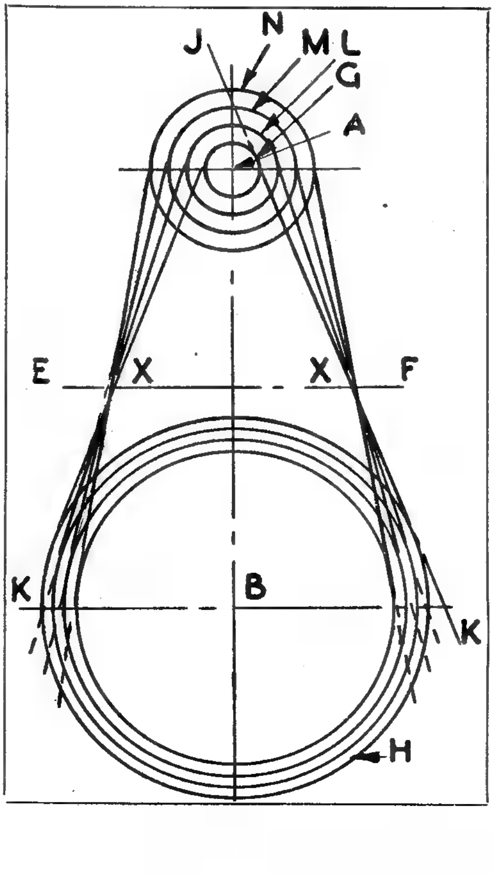
Although it has no direct connection with ignition equipment, as such, another item of electrical equipment in production in this factory interested me considerably, in view of its straightforward and workmanlike design. This was [illegible] cycle dynamo employing the fairly orthodox features of [illegible] rotary magnet and "horseshoe" stator with single exciting coil, built into [illegible] die-cast housing of clean exterior design. It appeared to me to be [illegible] excellent example of how production efficiency can be attained by getting down to real essentials. The dynamo, of course, produces alternating current, and forms part of [illegible] lighting outfit of consistently neat design, embodying a cable-controlled switch and head-lamp dipper.

Multi-Speed Belt Drives

In fitting up a multi-speed belt drive to a lathe or similar machine in which the opposed sets of pulleys are not of equal sizes, the problem arises of how to calculate the relative sizes of the pulleys in order to maintain [illegible] constant belt tension.

The first principle is simply arithmetical. The sizes of the largest driving cone and the smallest driven cone depend entirely on the relative speeds required. If the lathe is to make five turns to the driving shaft's one, at top speed, the proportion of the diameter of the driving cone to that of the driven should be five to one. The diameters required for the other steps can be set out geometrically, by the following construction.

Draw to scale the intended distance between the centre of the mandrel (*A*) and the centre of the driving shaft (*B*). Bisect this line *AB* and draw *EF* [illegible] the perpendicular to the point of bisection. With *A* as the centre, draw the concentric circles *G*, *L*, *M*, *N* to represent at full scales the four steps of the cones on the mandrel. Then as *G* represents the cone of smallest diameter, the diameter of the largest step of the driving pulley, calculated from the example given above, can be drawn as [illegible] circle *H* of that diameter on *B* [illegible] centre. Construct the tangent (*JK*) common to both circles *G* and *H*, and call the point at which it intersects *EF*, *X*. Draw tangents to the circles *L*, *M* and *N*, through *X*, and produce them beyond this point. The correct circles, to represent the remaining steps of the driving pulley, can then be drawn, concentric with *H*, and touching these lines.—J.W.



IN THE WORKSHOP

by "Duplex"

61.—*Building the $\frac{3}{8}$-in. Cowell Drilling Machine from Castings

ALTHOUGH there is usually no difficulty in arranging the drive of a drilling machine by electric motor so that high speeds can be obtained, the provision of an efficient, low-speed drive is a less easy problem. Machining at low speeds is often required in the small workshop, as when counterboring and heavy countersinking operations are undertaken, for in this way chatter can be avoided and the tool is kept cutting effectively and not merely rubbing in the work.

Moreover, the largest size carbon-steel drills that the machine can accommodate require to be run at relatively slow speed ; this is particularly important when cast-iron is being drilled, for if the drill is not kept cutting freely, its cutting lips are apt to become worn, and the drill is then prone to jam in the work until the form of the point has been restored by grinding.

A device to increase the speed range of this machine was described in a previous article, and one modified in this way continues to give satisfactory service in our workshop.

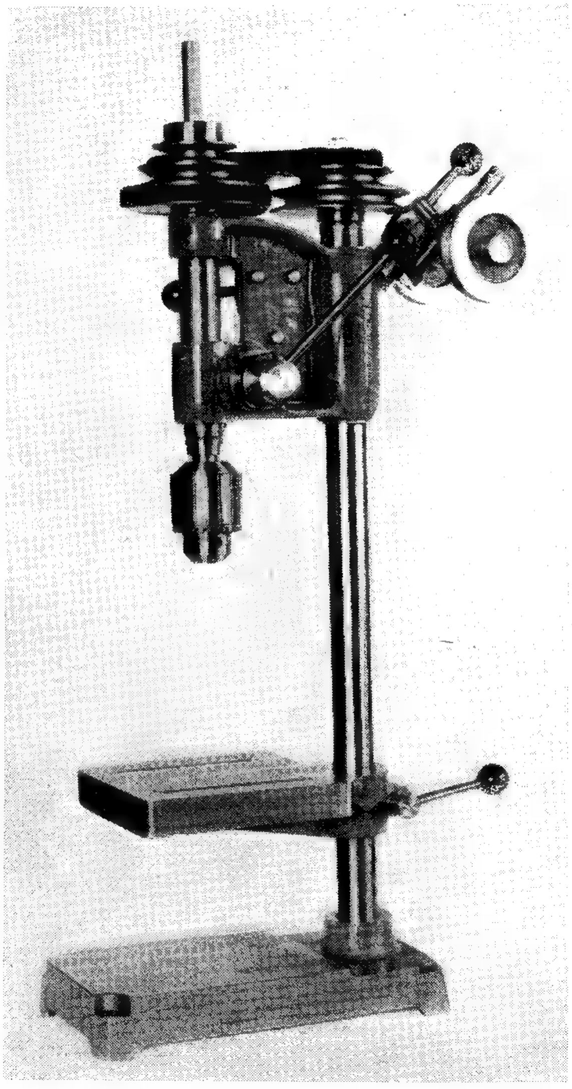
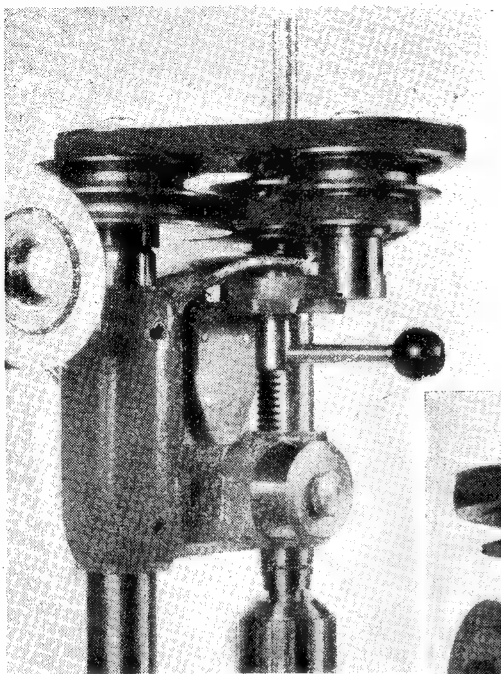


Fig. 1. The finished machine

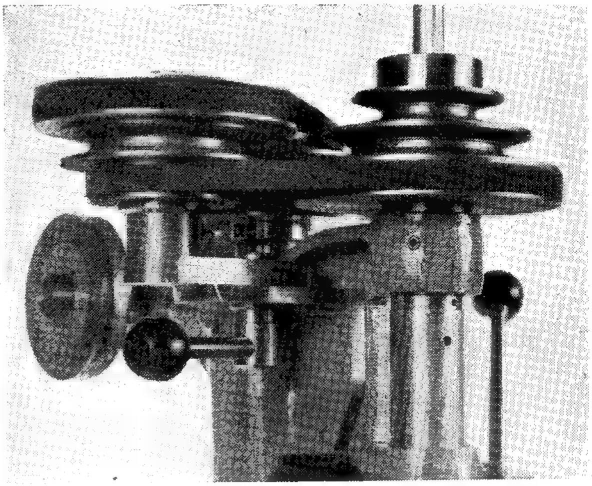
However, it was found that the drive in this form projected too far backwards to allow the machine, now under consideration, to be mounted in the space available on the bench and driven from the motor attached underneath.

It was decided, therefore, to redesign the multi-speed drive and make it more compact, so that the jockey pulleys did not project more than $\frac{1}{2}$ in. backwards in relation to the standard design. The general construction will be apparent in the photographs of the complete machine, and the closer views should make clear the design of the V-belt drives. It will be seen that the first pulley, driven by a round belt from the power source, is mounted on a spindle attached to the upper end of the main column. Thence, the drive is by V-belt to a second or intermediate V-pulley which, in turn, drives the third or spindle pulley that rotates the drill spindle by means of sliding keys. The spindle of the intermediate pulley is attached to a slotted swing-arm, so that immediate adjustment of the tension of both V-belts can be readily made ; likewise, the belts can be slackened when it is desired to alter the drive ratio to change the drilling speed,

*Continued from page 482, "M.E.," April 6, 1950.



Above—Fig. 2. Showing the first and second pulley mountings



Right—Fig. 3. The drive from the second to the spindle pulley

for, as belt manufacturers point out, the design of the drive is at fault when tightened belts have to be sprung over the pulley rim to alter the driving speed.

Spindle Speeds

The approximate drilling speeds obtainable, when using a motor running at 1,450 r.p.m. fitted with ■ single pulley, are : 200 : 270 : 400 : 460 : 720 : 1,360 : 4,600 r.p.m., but if a two- or three-step pulley is fitted to the motor, additional intermediate speeds, as well as higher speeds, become available.

Moreover, by keeping the initial round-belt drive from the motor confined to the large diameter step on the first pulley, and altering only the position of the V-belts on their pulleys, the following speeds are obtained : 200 : 400 : 1,360 r.p.m.

This change can be quickly made, and the high speed will be found useful for driving small centre drills and for pilot drilling, whilst the two slower speeds will serve for larger drills.

Pulley Groove Angles

At first sight, it might be thought that the pulley grooves should be turned to the same angle as that formed by the sloping sides of a piece of straight V-belt, but if the belt is bent with the fingers to form a curve of small radius, it will be seen that the inner part of the belt bulges, thus making the sides more nearly parallel. To maintain good belt contact, therefore, the pulley groove angle is lessened as the diameter of the pulley is reduced. Fortunately, belt and pulley groove angles have now been standardised, so that reference to ■ belt manufacturer's catalogue will furnish all the particulars required. In the present case, the groove of the smallest pulley is machined to an included angle of 32 deg., and that of the largest to 38 deg. The middle groove of the pulleys has ■ pitch diameter lying approximately midway between those requiring ■ 34 and ■ 36-deg. groove ; this pulley is therefore machined to an included angle of 35 deg.

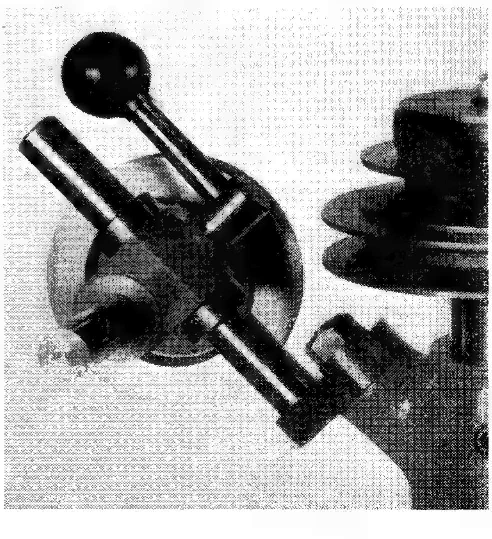


Fig. 4. The jockey pulley assembly

If a little trouble is taken to turn the pulley grooves accurately, it will be found that the belts will grip well even when run a little slack, and there will be no need to employ excessive tension to obtain a satisfactory grip under working conditions ; furthermore, this will save bearing wear

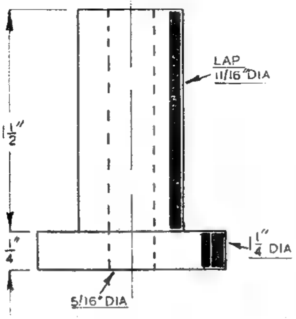


Fig. 5. The mild-steel spindle for the first pulley

and will also prolong the working life of the belt. In addition, to obtain satisfactory working, with the short drive centres used, it is essential to mount the pulleys so that their corresponding grooves are exactly in line in the horizontal plane.

Quiet running and absence of wear are ensured by lapping the bearing surfaces of both the pulleys and their spindles.

Constructional Details

The first V-pulley, being that driven by the round belt from the power source, is mounted on the upper end of the main column. For this purpose, the column is drilled and tapped in the manner previously described for fitting the base casting. Should the base have already been fixed to the column, there is no need to remove it ; for when carrying out the machining in the lathe with the aid of the fixed steady, the base can, it was found, quite well be supported on a wooden block resting on the lathe bed.

The pulley spindle is machined to the dimensions given in Fig. 5, and it is essential that the central bore should afford ample clearance for the long stud or hexagon-headed screw that serves to secure the spindle to the column. The bearing portion of the spindle is finally lapped to afford the pulley a close and accurate running fit. A small oil reservoir will be formed if the upper end of the spindle is machined to lie a short distance below the surface of the pulley. The third or spindle-driving pulley remains as already fitted and requires no alteration, but the position of the headstock on the column must be adjusted, by means of a rule or straight-edge, to set this pulley and the first pulley on the same level.

The Intermediate Pulley Mounting

To enable the second or intermediate pulley to be mounted on the headstock, the bracket shown in Fig. 6 is secured to the headstock casting by means of three 2-B.A. hexagon-headed screws of the form depicted in Fig. 7.

The bracket was hacksawn and filed to shape from a piece of angle iron, and the upper surface was filed flat and then drilled and slotted as shown in the drawing. When the three tapping-size holes have been drilled in the bracket, it is clamped in place to act as a guide for drilling the screw holes in the headstock casting. At the same time, the bracket is positioned, with the aid of a block and a straight-edge, so that its upper surface lies truly parallel with the faces of the pulleys already in place. The screw holes in the casting are spot-faced for the attaching screws and then enlarged to the clearing size. Owing to the irregularities on the surface of the casting, there is no flat bolting face for the bracket ; it is advisable, therefore, to fit thin washers under the bracket in order to give this part a three-point bearing. By varying the thickness of the washer at the lower end of the bracket, the bracket itself can, if necessary, be tilted slightly to align the upper face truly parallel with the pulleys.

The swing-arm, shown in Fig. 8, is clamped to the bracket by means of the screw and handled-nut illustrated in Fig. 9.

The hole in the arm is reamed to size, and the screw is made a light force-fit to prevent rotation when the clamp-nut is tightened. The outer end of the arm is drilled and tapped $\frac{5}{16}$ in. B.S.F. to receive the long stud, Fig. 10, that secures the pulley spindle in place. It will be seen that, to allow the clamp-nut to be screwed on to the clamp-screw, the ball-headed handle

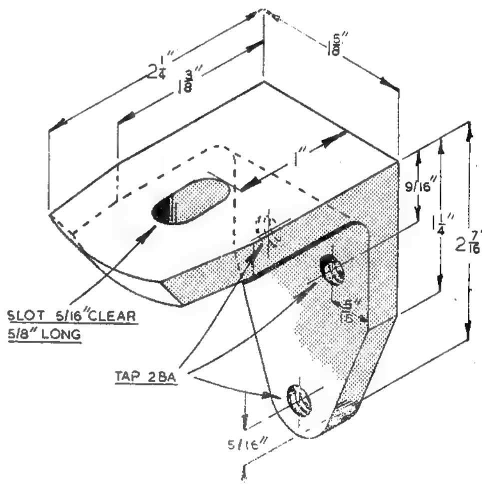


Fig. 6. The bracket for carrying the intermediate pulley swing-arm

fitted to the nut is made detachable. The clamp handle is finally brought into a convenient operating position by fitting a washer of the correct thickness.

The intermediate pulley spindle, Fig. 11, is bored a clearance fit for the central fixing stud, and the bearing portion is lapped to receive the pulley. As the height of the shoulder on the spindle base determines the position of the pulley, this dimension must be accurately computed in order to bring the pulley's surface exactly level with that of the other two pulleys. Although the

value of this dimension given in the drawing is the measurement that was actually used, it is quite possible that any slight variation in the fitting of the bracket or in the thickness of the swing-arm will necessitate some small alteration. To allow the bracket arm to swing freely, the lower end of the central stud, securing the spindle in place, must not be allowed to project.

When the bracket and its fittings have been

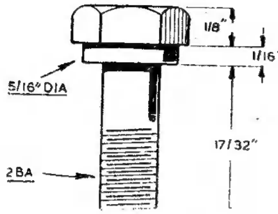
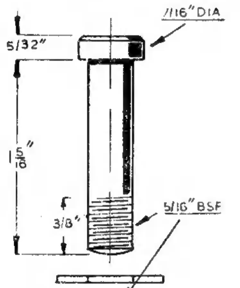
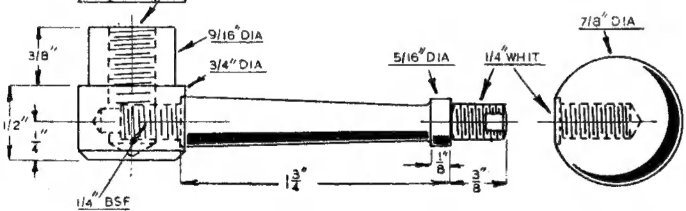


Fig. 7. Screws for attaching the bracket to the headstock casting





Left—Fig. 9. The clamp-screw and handled-nut used to lock the swing-arm

in for a distance of some $\frac{1}{2}$ in. into the tapped hole already machined in this position.

Driving Belts

For the V-belt drives, two Fenner M-type belts were used of a length denoted by the symbol 2160.

Normally, in a belt drive including jockey pulleys the round belt twists as it passes from

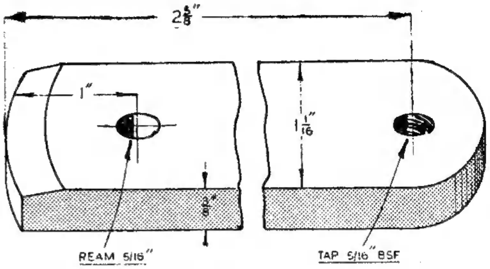


Fig. 8. The swing-arm carrying the intermediate pulley spindle

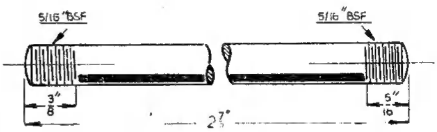


Fig. 10. Stud for attaching the intermediate pulley spindle to the swing-arm

assembled, it will be found that the V-belts can readily be simultaneously tensioned by pulling on the base of the pulley spindle with the crook of the left index finger and then tightening the clamping lever with the right hand.

The Jockey Pulleys

The only alteration here required is to mount the jockey pulley arm rather farther away from the first driven pulley. This is provided for by mounting the arm in a bracket or foot-piece which is, in turn, secured to the headstock casting. This method of mounting the jockey pulleys is illustrated in Fig. 12, and the detailed dimensions of the bracket are given in Fig. 13. To afford additional security, an Allen grub-screw may be fitted to the bracket to keep the jockey pulley arm from rotating when the machine is in use.

The bracket itself is attached to the headstock casting by means of a $\frac{5}{16}$-in. B.S.F. stud, screwed

pulley to pulley, so that the belt fastener always remains upright in relation to the pulley grooves; but owing to the rather short distance between the jockey pulleys and the driven pulley in the present instance, the round driving belt from the motor is given but little room to make this twist.

Should it be found, therefore, that the belt fastener tends to strike the pulleys, it will be advisable to fit either an endless rubberised canvas round belt, or to dispense with the belt fastener by forming a cemented and stitched lap-joint in an ordinary leather belt.

The Drilling Table

Those who have inspected used drilling machines at disposal depots will have noticed that the surface of the drilling table is often honeycombed along a curved path with drill holes of all sizes, as a result of consummate lack of care on the part of the operator.

Although no competent worker would damage a machine in this way, it is possible that in a moment of aberration a single drill mark may be made on the table and its appearance marred. To avoid this, it is advisable to provide a clearance hole for the drill at the centre of the table, or the table itself may be rotated to bring either of the bolting slots directly under the drill.

In the present instance, the table casting has a strengthening web which passes under the centre of the table and, if the somewhat unusual appearance is not objected to, a single, ½ in. diameter hole may be drilled on either side of the central web to form a through-way for the drill and, at the same time, to allow the work to be placed nearly centrally on the table when drilling.

Drill Chucks

Although the machine is rated at ⅜ in. drilling capacity, there are times when a cutter, having a ½-in. diameter shank, has to be mounted in the

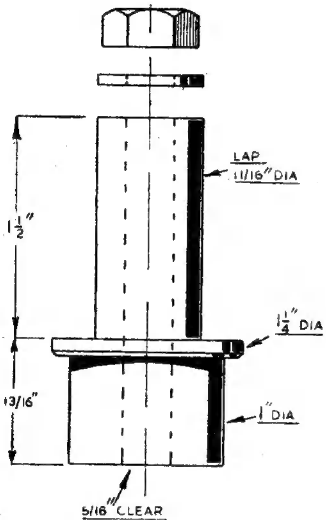


Fig. 11. *Steel spindle carrying the intermediate pulley*

chuck to perform some light machining operation such as forming a countersink or counterbore.

In this event, the adaptability of the machine will be enhanced if a chuck of ½ in. holding capacity is substituted for the standard ⅜-in. chuck. The Jacobs No. 33 light pattern chuck has a holding capacity of from 5/64 in. to ½ in. and, as it is but little larger than the standard ⅜-in. chuck, it in no way mars the general appearance of the machine.

Lubrication

Oil applied to the recesses at the top of the pulleys will tend to work its way downwards along the spindles, and, provided the speed is not excessive, the lubricant will not be flung out by centrifugal force. Lubrication, particularly when the machine is new, should not be neglected, although the closely-fitted, lapped, cast-iron to steel bearings should retain the oil film for a long time. Nevertheless, it is advisable from time to time to slack the V-belts and raise the pulleys on their spindles to make sure that the supply of oil is adequate.

Conclusion

If at any time the modified machine is wanted in its standard form, this conversion can be

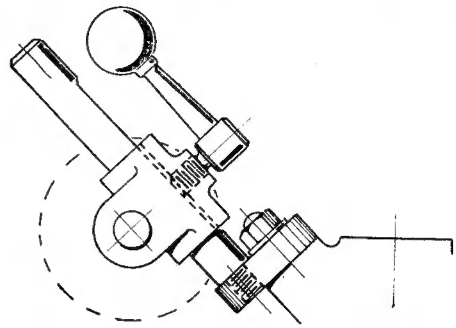


Fig. 12. *Method of mounting the jockey pulleys*

readily carried out merely by lifting the first and second pulleys off their spindles and fitting a longer round driving belt direct to the spindle pulley ; at the same time, the mountings of the first and second pulleys can be easily removed if not required.

When the machine has been completed, it is advisable to give it a period of running-in at slow and moderate speeds before it is put into general use, and during this time a periodic inspection of the bearings should be made to make sure that all are working freely.

After the machine had been finished, and before it had been run-in, a test was made with an accurate ammeter in circuit with the d.c. driving motor. The motor, running light, was found to consume 0.3 amp., and, when the

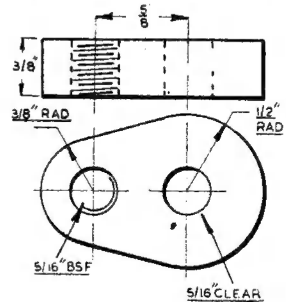


Fig. 13. *The foot-piece for attaching the jockey pulley arm to the headstock casting*

machine was connected, the meter showed 0.4 amp. only, with all the belt drives in operation.

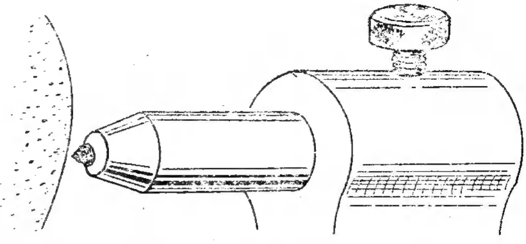
There should, therefore, be no reason to anticipate any serious loss of power, owing to friction, even with the machine operating at high speed.

To form an estimate of the accuracy of the finished machine, the so-called turn-round test was applied, and this showed that the front of

(*Continued on page* 571)

Notes on Grinding-Wheels

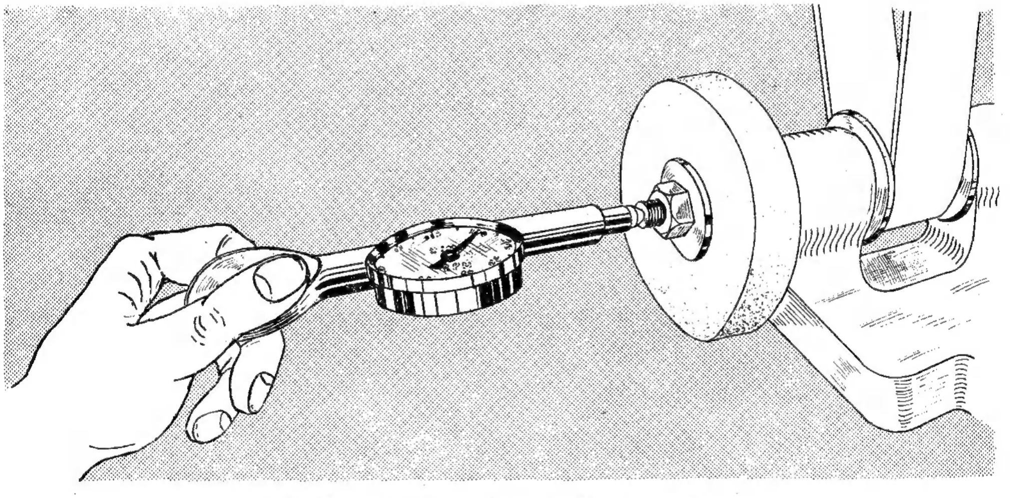
by M. Hall



A diamond tool for re-truing grinding wheel

I HOPE the following will be useful to model engineers who do their own grinding, whether they use the toolpost grinder, or perhaps, are lucky enough to possess a " pukka " machine.

The bond of a wheel defines the grade, and varies in quantity and mixture. Its job is to hold the particles of grit together, and a hard grade wheel will hold the particles more tenaciously than a soft grade wheel. The soft grade wheel loses its grit relatively easily, and presents resh sharp particles to the work.



Checking speed of grinding wheel by revs. indicator

Selection of Grinding Wheels

When grinding a hard material, the grit becomes dulled, and ceases to cut, merely rubbing against the work. This causes the wheel to clog, and can discolour and burn the work. To overcome the defect, a softer grade wheel is used, which will allow the dulled grit to be knocked off as friction increases. Generally speaking, therefore, use a soft wheel for hard material, and a hard wheel for soft material.

Speed of the Wheel

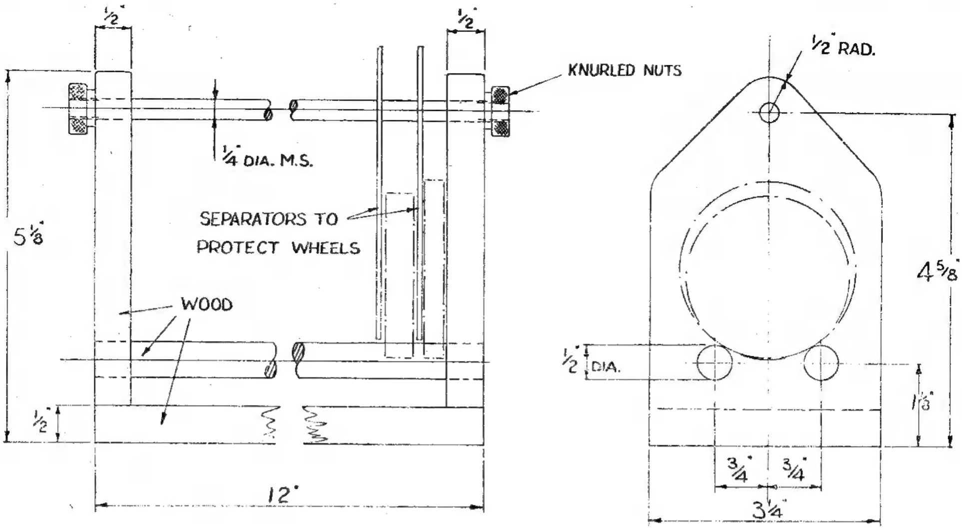
The usual peripheral speeds of grinding wheels are around 5,000-6,000 ft. per min., but this is sometimes altered to suit certain conditions, such as when a wheel tends to become clogged. A speed reduction will often cure this, provided that the grade of wheel is somewhere near correct. A point to remember is that, as the wheel is reduced in diameter due to wear, the peripheral speed also drops. As this happens, the r.p.m. should be increased accordingly. A few close approximations will give an indication of r.p.m. required.

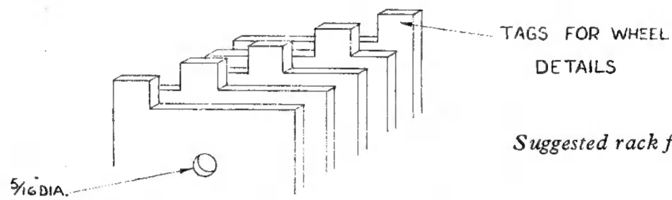
Dia. of Wheel	Peripheral Speed in ft. per min.	r.p.m.
2 in.	5,000	9,500
2 ,,	6,000	11,400
3 ,,	5,000	6,300
3 ,,	6,000	7,500
4 ,,	5,000	4,750
4 ,,	6,000	5,700

We find the speeds of wheels thus :—

$$\text{r.p.m.} = \frac{A \times 12}{D \times \pi}$$

where A = peripheral speed in ft. per min.
D = diameter of wheel in inches.





Suggested rack for storing wheels

When truing wheels, the best method is by a diamond tool, but one of these will not be possessed by many model engineers. An alternative method is to use an unfinished corundum stick, or even a broken piece of coarse wheel. I have seen wheels trued by the bottom end of a lemonade bottle!

Grinding Allowance

It is usual to leave from 0.010 in.-0.020 in. for grinding, but this again can vary with conditions. For example, a short stubby shaft can safely have as little as 0.006 in. left on, while a long spindle will obviously require more, to allow for any distortion due to machining or hardening.

Storing Wheels

It is worth the trouble to make a rack for storing wheels when not in use, and also to place a piece of cardboard between each wheel when they are likely to touch one another. A chipped wheel is out of balance, and will never give a good ground finish to the work.

In the Workshop

(*Continued from page* 569)

the drill table was higher than the back by three-thousandths of an inch. This is as it should be in a new machine, for all subsequent wear and the pressure exerted while drilling both tend to eliminate this initial slight error of alignment.

For the benefit of those unfamiliar with this procedure, the test is carried out in the following manner: the test indicator is clamped to a short centred rod held in the drill chuck; after the return spring of the feed lever has been slackened, the centred end of the rod is supported by a cycle ball resting on the drill table; with the test indicator in contact with the table, the drill spindle is turned by hand and readings are taken at four points at right-angles to one another.

Next, the test indicator was applied to the rod held in the chuck; this showed readings varying by only a half-thousandth of an inch when the drill spindle was rotated.

As a working test, a $\frac{1}{8}$ in. diameter pilot hole was drilled out to $\frac{3}{8}$ in., and following this, a $\frac{1}{2}$ in. diameter drill was put through the latter hole. The large drill cut cleanly without chatter or jumping and produced two continuous, coiled shavings; moreover, the hole so formed was a close clearing fit for the drill. During the latter drilling operation, the ammeter registered 0.5 amp. only, and the machine itself ran almost silently. Finally, the $\frac{1}{2}$ in. diameter hole was machined with a $\frac{5}{8}$ in. diameter countersink and, again, no tendency to chatter was experienced in spite of the rather heavy cut taken.